Faga’alu Watershed Plan Implementation Supplement

March 2013

Prepared for:

Faga’alu Village
American Samoa Environmental Protection Agency
NOAA Coral Reef Conservation Program

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1.0 Introduction

The purpose of this supplement is to provide additional information on watershed restoration projects and activities to support implementation of the *2012 Faga'alu Village Watershed Management and Conservation Plan*. Table 1 summarizes new and/or amended objectives and strategic actions to include in the existing action plan outlined in the 2012 watershed plan. This additional information is intended to supplement the existing plan and assist the Village Council and others to more easily integrate additional recommendations into the existing watershed planning framework. Unless specifically noted, the schedule and lead for implementation of each new strategic action are assumed to be consistent with what is specified in the existing watershed plan.

Table 1. Updated Faga'alu Watershed Management and Conservation Action Plan*

Objective	Strategic Action
Threat: Trash *(same number of objectives, add actions)*	
1. Raise awareness	1.1-1.4 no recommended changes
	1.5 (new) Establish quarterly or biannual Village household hazardous waste and white goods (appliances) collection days.
	1.6 (new) Education for businesses and hospital on improved dumpster management options.
	1.7 (new) Storm drain marking and install watershed signage
2. Clean-up committees	2.1-2.5, and 2.7 no recommended changes
	2.6 (amend) Install trash bins at the bus stop near Fanu Park and at the bus stop and boat house area at Faga'alu Park; biweekly collection.
	2.8 (new) Quarterly or biannual cleanups at public locations including the two parks and along the shoreline of the Matafao Elementary School.
3. Inspection Teams	3.1-3.5 no recommended changes
	3.6 (new) Remove trash accumulated in culverts and catchbasins as part of routine O&M in partnership with DPW; quarterly inspections (or more frequent).
4. Recycling program	4.1-4.3 no recommended changes
	4.4. (new) Investigate potential to use deposit collections from bottle or can recycling to discourage littering, and to potentially help support Village-scale O&M programs.
Threat: Sedimentation and Water Quality *(amended threat and add 3 new objectives)*	
5. Regulations	5.1-5.4 no recommended changes
	5.5 (new) Enforce existing 50-ft buffer regulation on new construction activities.
	5.6 (new) AS-EPA/DOC to consider applying more stringent buffer requirements on hill-sides, around remaining sensitive wetlands, and along coastal shorelines. Provide guidance on selective clearing, stream crossings, mitigation requirements, and exempted activities.
6. Planting trees	6.1-6.2 no recommended changes
	6.3 (amended) Where encroachment has occurred, indentify opportunities to re-locate structures outside of the buffer or to restore native vegetation and tree canopy during redevelopment or repair projects; Consider buffer enhancement in conjunction with stream stabilization projects.

Table 1. Updated Faga'alu Watershed Management and Conservation Action Plan*

Objective	Strategic Action
	6.4 (amended) Plant trees in buffer area during quarry corrective action and at proposed shoreline projects at Faga'alu Park and Matafao School.
7. Stabilization priorities and process for streams and shorelines	7.1 (amended) Priority shoreline stabilization areas include areas at Fanga'alu beach and Matafao Elementary School.
	7.2 no recommended change
8. (new) By the end of 2014, complete construction of priority structural projects to manage polluted runoff	8.1 (new) Village mayor, AS DOC and AS-EPA to work with Samoa Maritime on implementing the quarry corrective action plan. Funding to support construction efforts to be provided by NFWF. Continued monitoring of in-stream turbidity levels to be conducted by San Diego State University.
	8.2. (new) Village Mayor to work with ASPA on extending sewer line to remaining residences in watershed.
	8.3 (new) AS-EPA to work with Hospital or Matafao Elementary School to construct demonstration bioretention.
	8.4 (new) Resident to complete the final expansion of dry compost piggery. This is underway and could serve as a model for other facilities.
9. (new) By summer 2013 conduct stormwater infrastructure O&M	9.1 (new) Village Council adopt and implement a village-scale O&M plan that outlines routine and long-term maintenance of local drainage infrastructure.
	9.2 (new) Work with DPW to revise O&M map to include all drainage infrastructure in the village and identify sustainable funding mechanism to continue O&M over the long-term.
	9.3 (new) Provide technical training to Village leaders and DPW on stormwater management and drainage infrastructure O&M.
10. (new) By 2014 increase understanding and local awareness and of sources of bacteria and nutrient loading	10.1 (new) Village mayor and the American Samoa Interagency Piggery Management Council officially recognize the dry litter piggery conversion project as a successful watershed restoration activity.
	10.2 (new) Village Council and ASCC to complete an informal survey of the number of dogs and other domestic/feral animals living in the Village to evaluate the significance of animal waste as a source of bacteria loading. Based on findings, discuss the feasibility of animal waste management options (e.g., weekly cleanup of dog waste in parks, resident education).
	10.3 (new) Work with ASPA to map the complete sewer network in the Village. Maintain a record of sewer overflows/backups and repair response times.
	10.4 (new) Inspect stormwater manholes and outlet pipes for signs of dry weather discharges and suspicious odors and fluids. If a non-stormwater discharge is detected, identify and eliminate the source.
	10.5 (new) Work with individual businesses and residents to identify alternative disposal mechanisms for wash water and other discharges.
Threat: Fisheries *(revise existing objective numbering and add another objective)*	
11. (revised #) Establish Marine Protected Area	11.1-11.3 (renumbered, but no additional changes recommended)
12. (new) By 2014 improve fish passage in freshwater streams.	12.1 (new) Retrofit main bridge crossing in Faga'alu with concrete berms and baffles to create variable condition low flow channel.
	12.2 (new)ASCC to complete baseline study of in-stream fauna above and below crossings; performance monitoring post-restoration.

* numbering of actions and objectives is consistent with the numbering system in the 2012 Watershed Plan.

The remainder of this supplement describes specific restoration opportunities investigated during field assessment activities conducted in July 2012 by the Horsley Witten Group, the Center for Watershed Protection, American Samoa Environmental Protection Agency, the Faga'alu Village Mayor, and a diversity of local stormwater training workshop participants. In addition, the American Samoa Watershed Protection Plan (Vol. 2) provided useful background information on the watershed and preliminary management recommendations (Pederson, 2010). It should be noted that a comprehensive evaluation of the entire stream network was not conducted as part of this supplemental effort.

The report is organized into these remaining sections:

Section 2.0 **Structural Projects**—summary of 16 structural restoration projects (e.g., stormwater retrofits, culvert repair) identified in the watershed.

Section 3.0 **Non-structural Activities**—summary of 8 non-structural opportunities (e.g., infrastructure maintenance, trash clean ups, buffer re-vegetation, education and outreach) identified in the watershed.

Section 4.0 **Stormwater Infrastructure Operations and Maintenance Plan**—preliminary O&M plan to outline routine and long-term maintenance procedures for culverts, inlets, drainage pipes, and other infrastructure.

Section 5.0 **Watershed Implementation Schedule**—preliminary 5-yr schedule to guide watershed implementation activities.

Appendix A **Structural Restoration Project Factsheets**—more detailed description of each of the stormwater retrofits, culvert repair, and stream restoration projects discussed in Section 2.0.

Appendix B **Faga'alu Quarry Corrective Action Plan Memorandum (Dated 8/30/12)**—concept design and implementation recommendations for reducing sediment loading from the Samoa Maritime Quarry site.

This supplement provides additional support to the existing watershed plan by: 1) helping the meet additional US EPA watershed planning criteria by providing list of restoration opportunities (both structural and non-structural); 2) addressing sources of additional pollutants (Total Nitrogen, Total Phosphorus, and *Enterococcus*) causing water quality impairments; and 3) integrating with existing or planned projects that should be credited as watershed restoration projects.

2.0 Structural Projects

Opportunities for structural restoration projects were identified at 16 locations in the watershed (Figure 1). Structural projects include stormwater retrofits, shoreline stabilization, stream restoration, road and sewer improvements, culvert repair, and piggery conversions, which are all summarized in Table 2. Stormwater retrofits are engineered practices designed to better manage stormwater runoff from existing roads, parking lots and other land surfaces. Figures 2 and 3 illustrate the various retrofit practice types proposed for Faga'alu.

The stream restoration, stormwater retrofit, and culvert replacement project concepts are presented in **Appendix A**, which includes:

- A description of existing conditions, the proposed project, and key design elements;
- Initial sizing calculations, used to determine if retrofits would be able to manage the first 2 inches of rainfall, are also included for each project. The 2-inch standard was chosen as a default value since a rainfall distribution analysis was not available;
- Drainage areas, impervious cover, target water quality volume, and surface area estimates for each proposed retrofit are provided; and
- Photos illustrating the project concept.

A corrective action plan specifying erosion and sediment control practices (e.g., diversions, sediment basins and dust control techniques) for the quarry site (Site ID #16) was previously submitted to AS-EPA, Samoa Maritime, NOAA, and the National Fish and Wildlife Foundation in a memorandum dated August 30, 2012. NFWF is actively pursuing implementation funding and some implementation by the owner has been initiated, which should be evaluated. This memo is included in its entirety in **Appendix B**. Additional detail is not provided on the piggery conversion, sewer extension, or stabilization projects at this time (Figure 4), since AS-EPA, DPW, and ASPA already have considerable experience with these types of projects.

Table 2 includes a relative scale for construction cost and an initial project ranking based on feasibility, visibility, cost, and watershed benefits. Costs and ranking information is intended as a starting place for implementation discussion by the watershed planning team and should be considered preliminary. Actual implementation costs will need to include estimates not only for construction, but also include design engineering, permitting, and potential land acquisition costs that are better understood as project concepts become more refined.

The following projects are recommended for short-term implementation:

- Quarry corrective action plan—this is a chronic source of sediment to the bay in violation of the federal Clean Water Act and there is enforcement momentum.
- Sewer extension—get it on ASPA's improvement list immediately.
- Demonstration bioretention—either at the hospital or the elementary school where high visibility may help generate support for watershed education/restoration activities.
- Piggery conversion—complete the final expansion of dry piggery. This is underway and could serve as a model for other facilities in American Samoa.

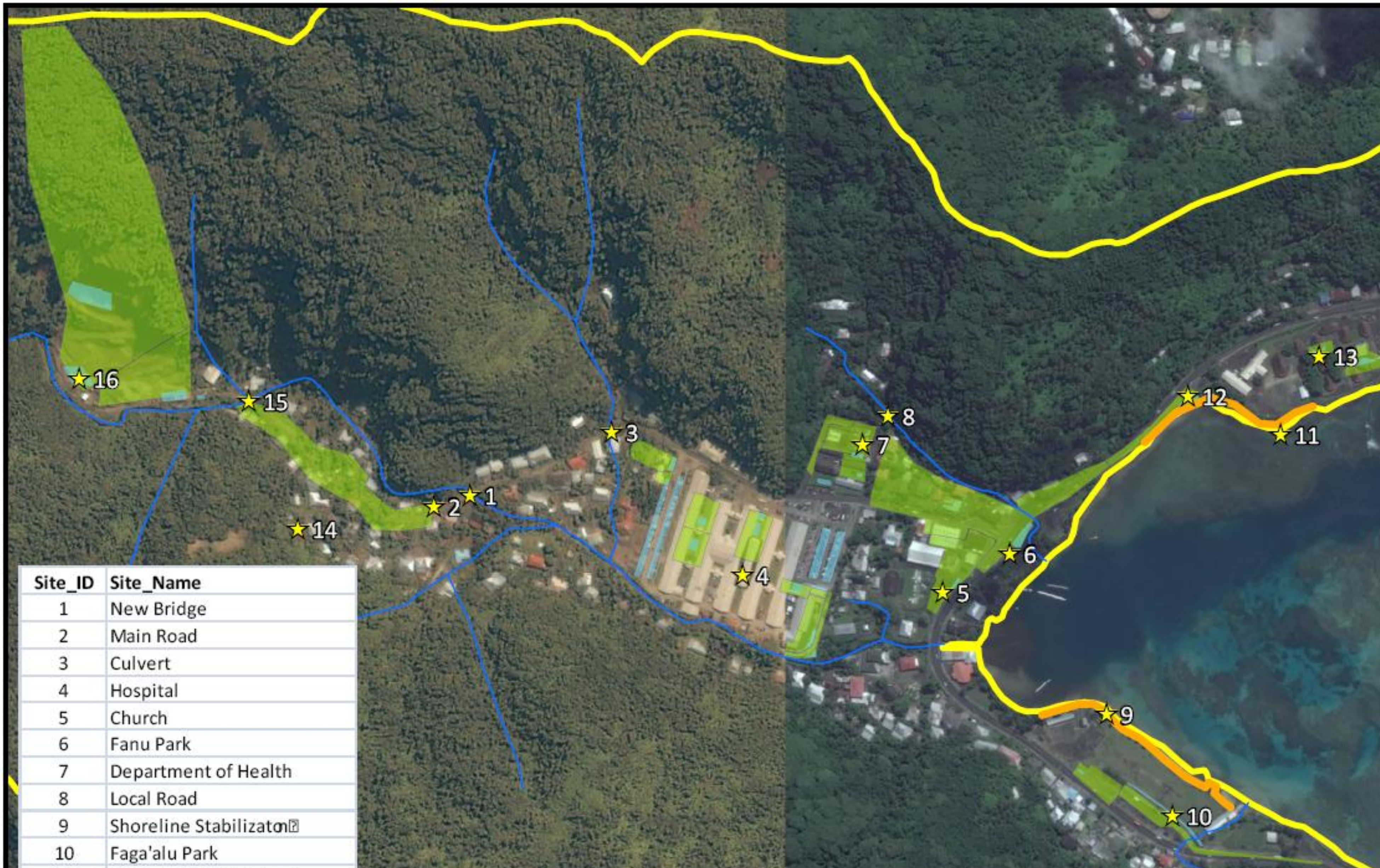
Table 2. Summary of Structural Restoration Opportunities

Site ID[1]	Project Type	Description	Relative Cost[2]	Initial Rank[3]
1. New Bridge	Stream Rest.	Improve fish passage at newly constructed bridge by installing a 6" high concrete wall and baffles to create low flow channel.	$	M
2. Main Road	Retrofit	Divert portion of road drainage into demonstration bioretention in existing open area; help reduce erosive flows visible in cinder/gravel areas above revetment.	$	M
3. Culvert	Culvert Replmnt.	Reduce flooding by replacing undersized culvert pipes with box culvert.	$$	L
4. Hospital	Retrofit	Numerous opportunities for rain gardens/bioretention, planters, and porous pavers (if repaving).	$ to $$$$	H
5. Church	Retrofit	Dry swale between road and parking lot.	$$	L
6. Fanu Park	Retrofit; Pollution Prevention	Separate dirty runoff from clean stream discharge; Realign existing stream in park; Treat commercial area and main road runoff with gravel mangrove.	$$$$	L
7. Dept. of Health	Retrofit	Bioretention, porous pavement, and sewer repair.	$$$	L
8. Local Road	Sewer Ext.	Connect remaining seven residences to sewer line, repave road and improve drainage.	$$$$	H
9. Shoreline at Faga'alu Park	Shoreline Stabil.	Restoration of seawall/revetment along shoreline (~900 ft), particularly near boat house.	$$$$	H
10. Faga'alu Park	Retrofit	Dry swale between field and parking lot to collect diverted road runoff; demo rain garden	$$	M
11. Shoreline at Matafao E.S.	Shoreline Stabil.	Extend rock seawall from new building around property to tie into wall at adjacent beach (~740 ft)	$$$$	M
12. Road ROW	Retrofit	Divert portion of 001 road drainage into bioretention.	$$$	L
13. Matafao E.S.	Retrofit	Tie into historic outfall pipe; install shallow bioretention in inner courtyard with; rain garden near new building.	$$	H
14. Piggery Conversion	Pollution Prev.	Partial conversion of private piggery from wet to dry compost; next phase is completion of final upgrade with AS-EPA grant; stabilize cut slope.	$	H
15. Stream Crossing	Culvert Replmnt.	Install box culvert to eliminate continuous flow across road surface.	$$$$	L
16. Quarry	Erosion & Sed.Cntrl.	Divert groundwater seepage around site; install storage practices at a number of locations throughout the site; buffer enhancement for dust control. See **Appendix B**.	$$$$	H

[1] Site numbering matches locations in Figure 1 map.

[2] Where $= less than $25k; $$= less than $50k; $$$=less than $100k; $$$$= more than $100k

[3] Ranking based feasibility, visibility, cost, and watershed benefits (L=low; M=medium; H=high)



Site_ID	Site_Name
1	New Bridge
2	Main Road
3	Culvert
4	Hospital
5	Church
6	Fanu Park
7	Department of Health
8	Local Road
9	Shoreline Stabilizaton
10	Faga'alu Park
11	Shoreline Stabilizaton
12	Hwy 001 ROW
13	Elementary School
14	Piggery Conversion
15	Stream Crossing
16	Quarry

Legend

- Structural Projects
- Practice Area
- Drainage Area
- Shoreline Stabilization
- Streams (revised HW)
- Faga'alu Watershed

N

500 250 0 Feet

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Sustainable Environmental Solutions

Figure 1. Proposed Structural Projects
Faga'alu Watershed
Tutuila, American Samoa

Date: 11/14/2012

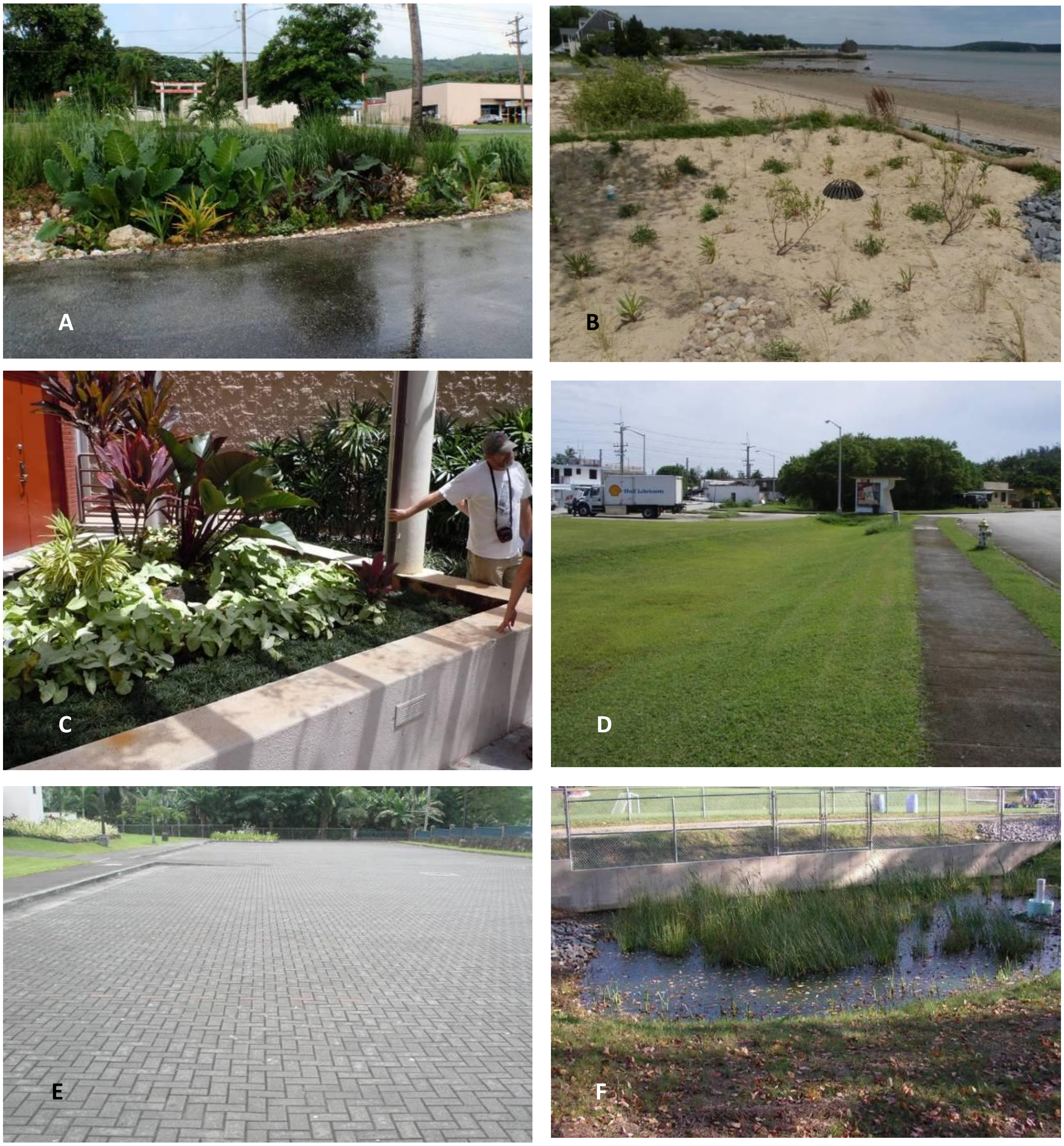
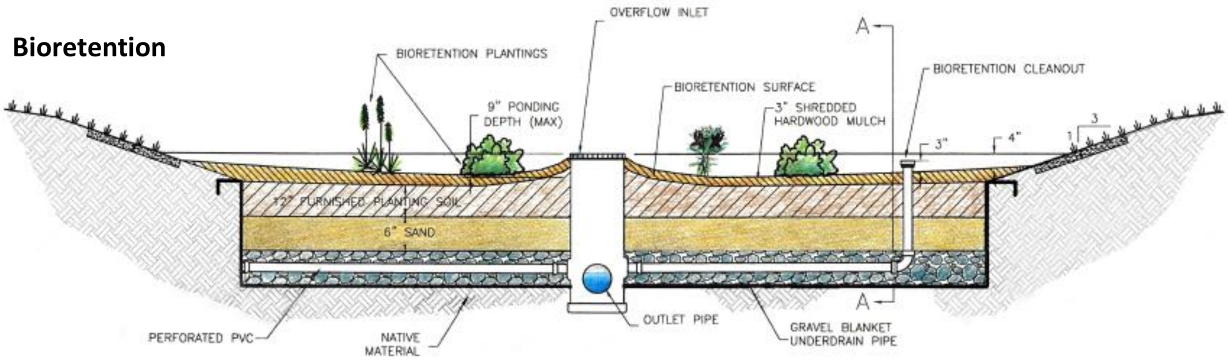
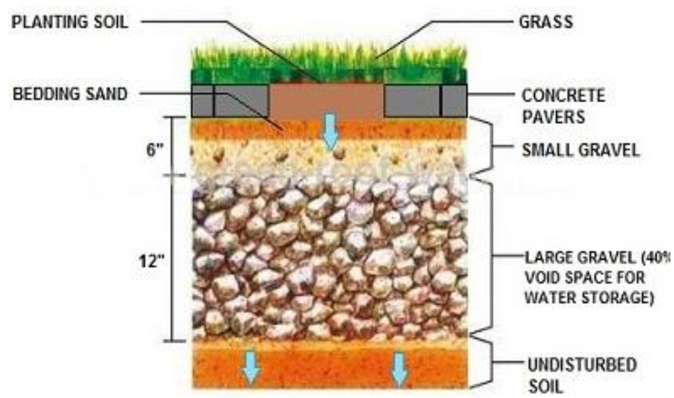


Figure 2. Example stormwater retrofit practices. A) Rain gardens, B) bioretention, and C) planter boxes are vegetated depressions with amended soils to filter and/or infiltrate runoff. D) Dry swales are grassed, linear conveyances with engineered soils to enhance infiltration. E) Structured pavers or porous concrete/asphalt allow water to infiltrate through the hard surface into belowground gravel storage beds. F) Gravel wetland/mangroves are treatment systems using native wetland species to uptake pollutants before discharge.

Bioretention



Porous Pavers (Grass Pavers, from AS-EPA building signage)



Dry Swale (Grassed)

Gravel Wetland (from UNH)

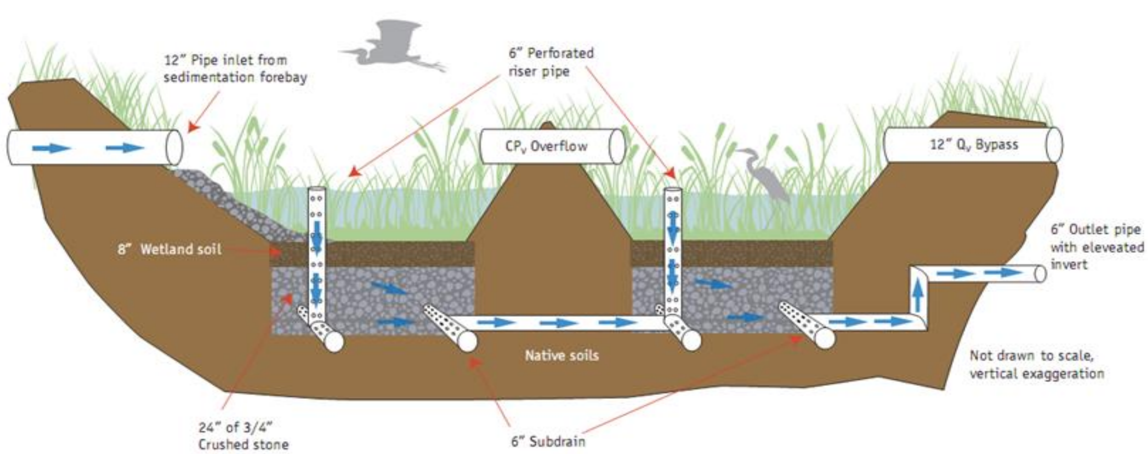


Figure 3. Representative profiles of four recommended retrofit practices in Faga'alu.

Figure 4. Structural projects not further described in Appendix A are: A) Site ID #13 completion of a dry compost piggery expansion project (small upgrade and cut slope at new location shown here); B) ID #9 and #11 shoreline stabilization at Matafao Elementary School and Faga'alu Park shown here, respectively; and C) ID #8 sewer extension and road improvement project for residential area above the Dept. of Health.

3.0 Non-Structural Opportunities

In addition to the structural practices discussed in Section 1.0, a number of non-structural activities were identified to improve water quality conditions in the Faga'alu watershed. Non-structural measures include re-vegetation of stream buffers; regular infrastructure maintenance activities; trash and animal waste management; and addressing illicit discharges. These activities, along with watershed education and outreach opportunities, are summarized in Table 3 and described in more detail below. A preliminary Operations and Maintenance (O&M) plan for Village Stormwater Infrastructure is provided in **Section 4.0**.

Table 3. Summary of Non-Structural Activities in the Faga'alu Watershed.

Project Type	Description	Proposed Locations
Culvert/catchbasin maintenance	Clean out sediment, debris, and trash collected in existing culverts; develop an O&M plan and solicit funding to support Village-run maintenance program for culverts and catch basins (see **Section 4.0**).	Hwy 001 at Faga'alu and Fanu parks (see Figure 10)
Trash management	Install trash cans at strategic locations; conduct Village stream cleanups and link with recycling deposit collection; organize Village household hazardous and solid waste collection days; work with businesses to maintain covered dumpsters.	Bus stops; parks; school; commercial dumpster along Hwy 001 (see Figure 6)
Buffer protection and re-vegetation	Maintain 50ft vegetated/natural buffer between structures and streams/shorelines; maintain canopy shading for in-stream temperature regulation, habitat, and bank stabilization; re-vegetate shorelines with trees and other species as part of stabilization projects.	Quarry, parks, and (where feasible) in the village when redevelopment, repair, and new construction opportunities arise
Identification and elimination of non-stormwater discharges	Work with ASPA to identify and eliminate illicit discharges including sanitary sewer overflows/leaks during ongoing inflow and infiltration evaluation (estimated at 30-40%).	Junction manholes and exposed lines at stream crossings
Animal waste management	Continue with piggery conversion; investigate impact of dog waste on water quality.	Village-wide
Watershed education	Watershed signage was scheduled for installation in early August; residential campaign to discuss proper disposal of wash water, car fluids and other wastes (similar to Piggery flyers/campaign); develop watershed restoration materials to be shown at public gatherings and events; integrate with school or hospital demonstration retrofit project; create a watershed field trip/curriculum for students.	Village-wide
Public involvement	Trash cleanup in streams and shorelines; volunteer installation and maintenance of demonstration rain garden/bioretention.	Village-wide; demonstration site

3.1 Faga'alu Village Operation and Maintenance (O&M) Plan for Drainage Infrastructure

The stormwater infrastructure in the Faga'alu watershed consists of a network of culverts, drain inlets, catchbasins, drain pipes, and outfalls draining directly to the stream or to the bay. Clogging with debris and trash was observed in many of these structures, and repair or replacement of deteriorating or undersized structures is needed in some cases. Local leaders and agency staff agreed that current maintenance levels are not adequate to ensure proper function of the system (Figure 5). Locally-driven O&M should result in increased inspection frequencies; increased response time to minor drainage complaints, reduced expenditures on costly/emergency repairs caused by years of neglect, and better engagement of residents in watershed management. **Section 4.0** contains a draft O&M plan for consideration by the Village.

Figure 5. Drainage infrastructure that requires both routine and long-term maintenance includes A) catchbasins, B) culverts, C) bridges, and D) outfall pipes.

The following activities are recommended:

- Develop an O&M map to include all drainage infrastructure to be inspected and maintained in the Village;
- Adopt and implement a village-scale O&M plan that outlines the routine and long-term maintenance procedures for local infrastructure; and
- Identify sustainable funding mechanism to continue O&M over the long-term.

3.2 Trash Management

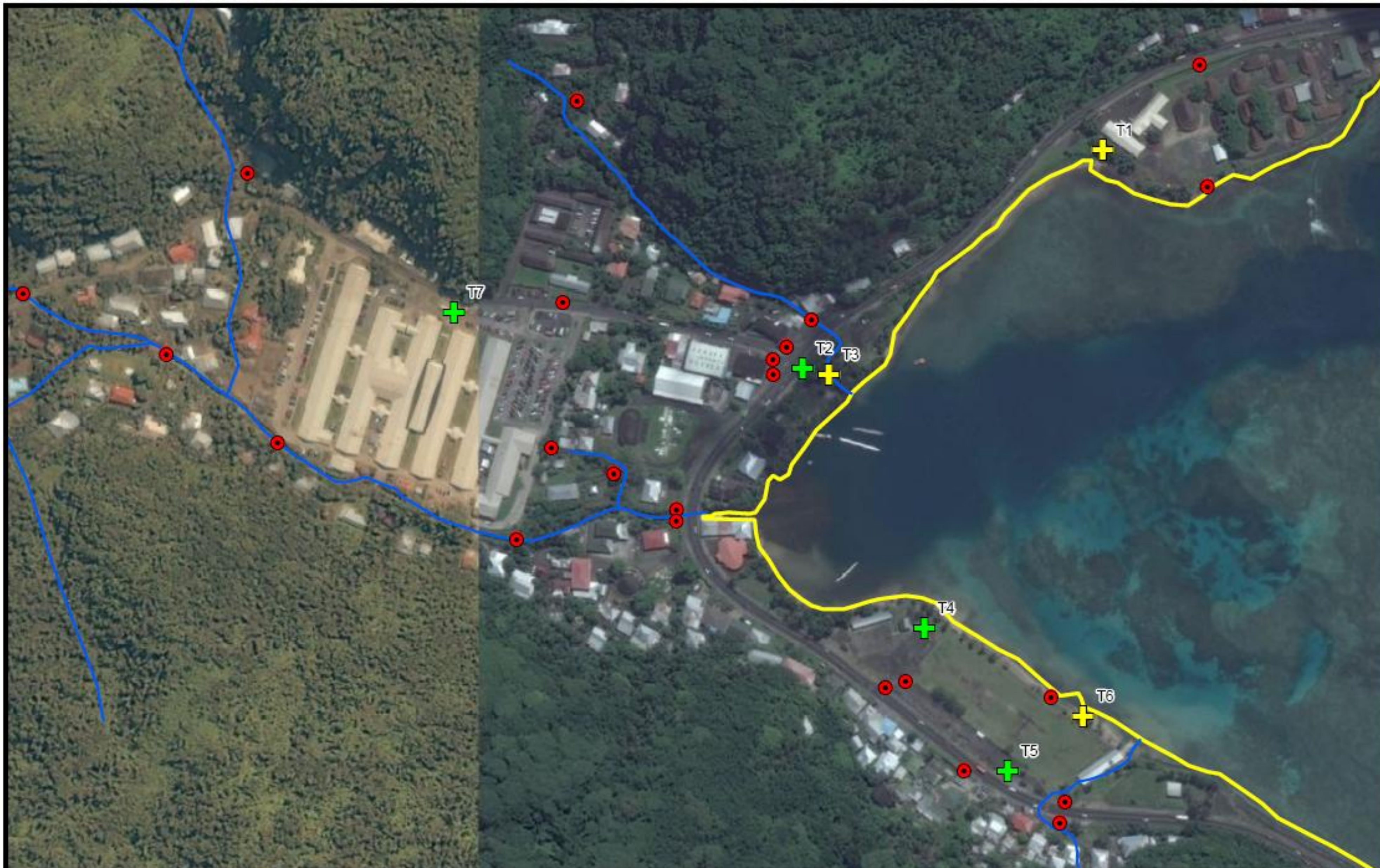
Trash reduction is one of the key management goals of the watershed plan, and community cleanups and trash bin placement was identified as actions towards meeting this goal. There are a number of priority locations where additional effort could be focused on trash prevention and cleanup (Figure 6). Activities should be integrated with the O&M and education plans, and may include:

- Improving dumpster management—Dumpsters should be covered to reduce contact with rainfall and removal by wind, and be located away from drain inlets and stream banks to minimize the chance that "dumpster juice" and floatables will be transported to waterways. A good example is the dumpster located in the commercial strip at the main intersection across from Fanu Park.
- Providing additional trash bins at key public locations, such as the two bus stop shelters in Fanu and Faga'alu Parks and the one at the Hospital. This will require a commitment to routinely collect trash in these bins before they overflow.
- Establishing quarterly or biannual household hazardous waste and white goods (appliances) collection days. The large parking lot at Faga'alu Park would provide a central location for hosting an event.
- Investigating potential to use deposit collections from bottle or can recycling to discourage littering, and to potentially help support Village-scale O&M programs.
- Removing trash accumulated in culverts and catchbasins as part of routine O&M.
- Quarterly or biannual cleanups at public locations including the two parks and along the shoreline of the Matafao Elementary School.

3.3 Buffer Enhancement

A wide body of research suggests the importance of vegetated stream buffers to protect the quality of streams and wetlands (e.g., bank stabilization, wildlife habitat, in-stream temperature moderation) and mitigate the impacts of nearby land development activities (e.g., Wenger, 1999). Like many villages on Tutuila, existing development in Faga'alu is concentrated within the main stream valley and along the coast; which resulted in the construction of homes, businesses, roads, and other structures within the stream corridor. Portions of the stream network have been straightened and channelized to more quickly convey flows through the watershed, reduce flood impacts, and prevent localized erosion. Often, these activities can have an unintended, negative impact on water quality, in-stream habitat, and downstream stability. Locating structures outside of a designated buffer area/floodplain is ideal, particularly as climate change reveals long-term changes in sea level, groundwater table, and storm intensity.

American Samoa has a 50-ft buffer setback requirement to protect streams by preventing encroachment of structures and removal of vegetation within the stream buffer. Figure 7 shows a 50-ft buffer overlay on Faga'alu streams. Based on available mapping information, there are approximately 24,130 linear feet of stream in the watershed. The red line roughly indicates 7,434 feet of stream (31% of the total network) where structures have encroached within the 50-ft buffer.



Legend

- trash bin
- trash cleanup
- Drainage Infrastructure
- Streams (revised HW)
- Faga'alu Watershed

350 175 0 Feet

N

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Figure 6. Trash Management Locations
Faga'alu Watershed
Tutuila, American Samoa

Date: 11/19/2012

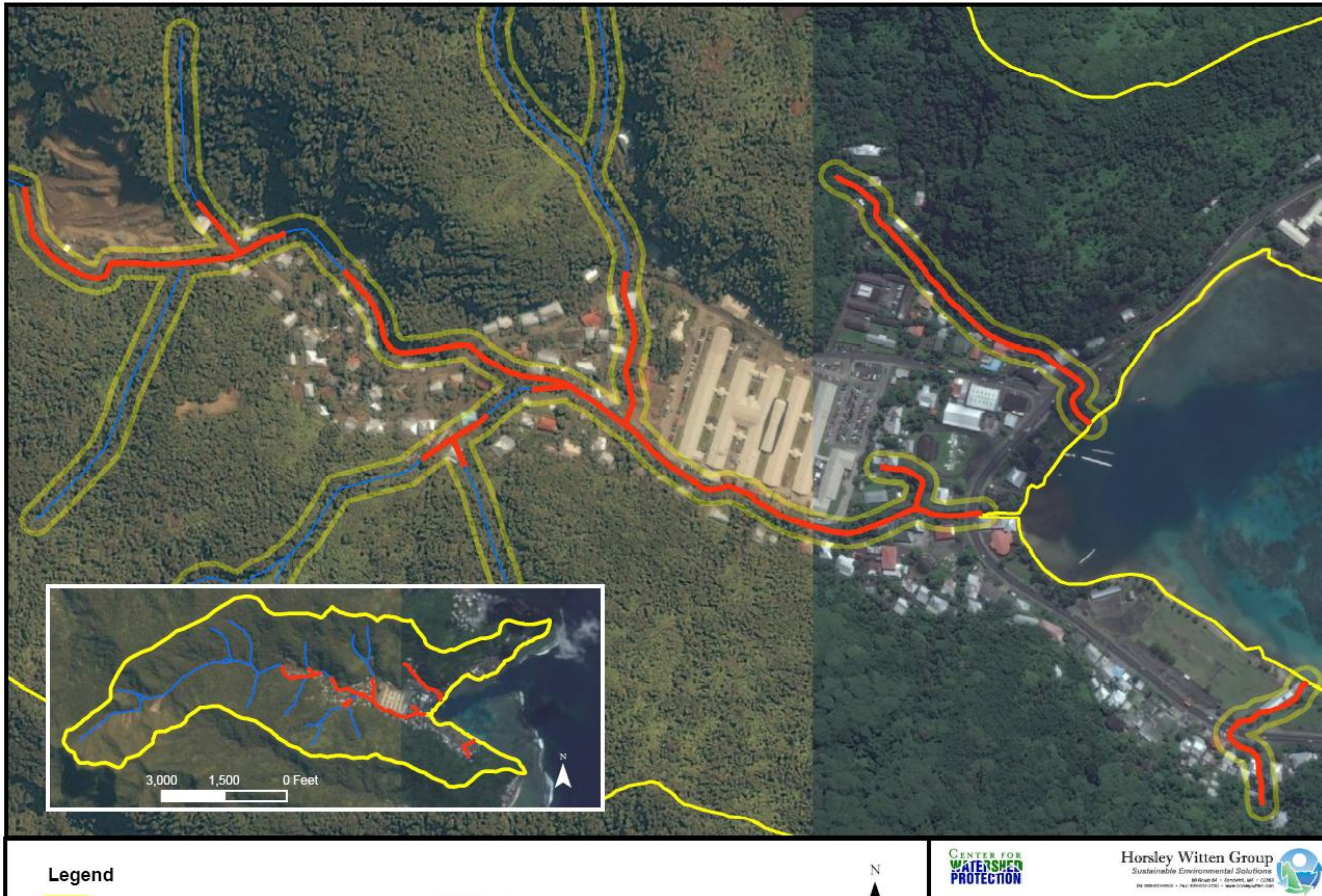

Figure 7. Stream Buffer Encroachment
Faga'alu Watershed
Tutuila, American Samoa

Date: 11/19/2012

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Restoration of impacted vegetated buffers is a common and relatively inexpensive strategy for watershed restoration; however, extensive buffer restoration seems impractical for much of the Faga'alu Village due to existing development and/or flow conveyance requirements (Figure 8). The following actions are recommended:

- Enforce existing 50-foot buffer regulation on new construction activities;
- Consider buffer enhancement in conjunction with stream stabilization projects identified in the watershed management plan;
- Where encroachment has occurred, look for opportunities to re-locate structures outside of the buffer or to restore native vegetation and tree canopy during redevelopment or repair projects (e.g., during implementation of quarry corrective actions, or include as a component of all shoreline stabilization projects); and
- Consider applying more stringent buffer requirements on hill-sides, around remaining sensitive wetlands, and along coastal shorelines. Provide guidance on selective clearing, stream crossings, mitigation requirements, and exempted activities.

Figure 8. Examples of stream reaches where encroachment has occurred and streams are clearly impacted. These locations also illustrate the difficulty of restoring natural buffer conditions without relocating structures or reducing capacity of the system to handle large flows.

3.4 Animal Waste Management

Animal and human waste contains bacteria and other pathogens as well as nutrients that can impact water quality and human health. Table 4 compares bacteria density in feces for a number of species. A 2003 survey by Centers for Disease Control and Prevention (CDC) found 17% exposure on Tutuila to *Leptospirosis*—a bacteria found in animal urine that can be transmitted to humans through contact with contaminated soils or water (Minshew and Scales, 2007). *Enterococcus*—a type of bacteria found in feces that is commonly used as an indicator of water quality—has been found by AS-EPA in levels exceeding water quality standards in Faga'alu. The unmanaged waste from all the dogs, rodents, chickens, and pigs in the watershed may be contributing to high bacteria/nutrient levels, although leaking sewer connections and failing septic systems are also potential sources.

Table 4. Comparison of Bacteria Density in Animals

Animal	Mean Fecal Coliform Densities per Gram of Feces
Humans	1.3×10^{7}
Dogs	2.3×10^{7}
Rats	1.6×10^{5}
Cows	2.3×10^{5}
Chickens	1.3×10^{6}
Pigs	3.3×10^{6}

Data from Wagner and Moench (2009) and CWP (1999)

To reduce the impacts of animal waste in American Samoa on human health, the CDC recommended controlling dogs and rodents and improving pig waste management (Minshew and Scales, 2007). AS-EPA inventoried over 1,000 active piggeries (~10,000 pigs) in the territory and adopted a number of piggery compliance requirements including: setback regulations of 100-ft from wells and 50-ft from streams; design features for structural enclosures; and waste disposal procedures (see http://asepa.gov/piggery-compliance.asp for more information). Technical and financial support has been made available for residents to convert existing piggeries to dry composting facilities, and significant effort has been made to educate islanders on the link between animals and disease/pollution. In fact, one of the two piggeries in the Faga'alu watershed has already been converted to a dry compost facility (Figure 9).

Figure 9. This dry litter piggery is a pen with a roof and sloped concrete floor. The waste is collected in a trench and then is composted with dry plant material such as wood chips or coconut husks.

We recommend the following additional actions be taken in the Faga'alu watershed:

- Have the Village mayor and the American Samoa Interagency Piggery Management Council officially recognize the dry litter piggery conversion project as a successful watershed restoration activity;
- Complete an informal survey of the number of dogs and other domestic/feral animals living in the Village to better evaluate the relative significance of animal waste as a source of bacteria loading; and
- Discuss the feasibility of alternative methods of managing animal waste (e.g., weekly cleanup of dog waste in the park, homeowner education).

3.5 Eliminating Non-Stormwater Discharges

Non-stormwater discharges include flows conveyed to stormwater inlets and pipes that are not derived directly from rainfall (e.g., raw sewage, septic discharge, wash water from businesses or homes, used engine oil disposal). For example, wash water from restaurants, gas stations, and residences has been observed being discarded onto the paved road, where it then drains to drain inlets. Once in the stormwater drainage system, these discharges quickly carry pollutants directly to streams and the bay. Most of the Faga'alu watershed has been sewered, but there is one remaining section of homes on individual septic systems. Sewer lines are not always watertight, connections can leak, cross-connections to the stormwater drainage can be unintentionally made, and groundwater infiltration and inflow can occur (I&I). In fact, ASPA reports that there is approximately 30-40% I&I in their sewer system (personal communication, 2012).

Based on observations in the watershed, we recommend the following activities:

- Contact ASPA to request sewer extension to remaining homes on septic;
- Map the complete sewer and storm drain structural network in the Village (ASPA may have some of this already);
- Maintain a record of sewer overflows/backups and maintenance repair response times;
- Inspect stormwater manholes and outlet pipes for signs of dry weather discharges and suspicious odors and fluids. If a non-stormwater discharge is detected, identify the source of discharge and determine the best method for elimination. Follow up with implementation and/or enforcement measures as appropriate;
- Mark drain inlets with "no dumping" signage informing the public that drainage from the structure goes directly to the bay; and
- Work with individual businesses and residents to identify alternative disposal mechanisms for wash water and other discharges.

3.6 Watershed Education and Public Involvement

The watershed management plan highlights a number of key actions intended to increase awareness of key watershed threats. Objective 1 in the plan is to implement a targeted education and outreach campaign with a goal that over half of the Faga'alu residents will be greatly aware of trash and other environmental impacts in the watershed and are working cooperatively to address them. To be successful, the education campaign should target behaviors that negatively impact watershed health and to provide hands-on opportunities to actively engage watershed residents, businesses, park users, and government officials in restoration efforts. Key behaviors identified in the watershed plan and confirmed during supplemental field observations include:

- Littering, dumping, and overall trash management;
- Pollution prevention in residential and commercial areas;
- Animal waste management;
- Fisheries enforcement; and
- Drainage infrastructure maintenance.

Table 5 summarizes some of the key watershed education actions included in the watershed plan, and recommends supplemental activities. Unlike most other watersheds in the US, the Village-based governance system in American Samoa is ideal for watershed messaging. Village meetings, church functions, and community gatherings are frequent and well-attended and should be used to raise awareness of watershed issues, recognize watershed-friendly actions, and promote participation in restoration activities. Integration of Faga'alu watershed education priorities with existing education programs in the Territory (e.g., the AS-EPA Environmental Education and Awareness Program and ASPA's solid waste education) will also improve the success of the watershed education campaign.

Table 5. Watershed Education and Involvement Activities

Existing Activities Included in Watershed Plan	Supplemental Activities
• Strategic Action 1.2. Implement Education and Awareness Campaign every 6 months; • Strategic Action 1.4. Educational programs at the Matafao school every quarter; • Strategic Actions 4.3 and 6.2. Outreach on the benefits of recycling, tree planting, and the problems with soil erosion; • Strategic Action 2.2. Public involved in trash cleanups; • Strategic Action 5.1. Local leaders trained on stormwater regulations; and • Strategic Activity (revised #12.1). Educational programs on proper fisheries management	• Post Faga'alu watershed signage (completed 2012?); • Provide technical training to Village leaders and DPW on stormwater management and drainage infrastructure O&M. This should include a tour of stormwater practices (e.g., EPA office building, parking lot at Mormon Temple, and Sadie's by the Sea); • Develop and distribute educational materials targeting better dumpster and animal waste management, as well as proper disposal techniques for wash water/used car fluids; • Assist businesses in the purchase and installation of covers, secondary containment units, and other pollution prevention measures. • Recognize residents and others (e.g., piggery owners) who have demonstrated good watershed stewardship at Village meetings; • Target quarterly trash clean ups at the parks and elementary school (see locations in Figure 6) and engage residents and students in storm drain stenciling; • Provide biannual household hazardous waste drop off; • Develop a watershed curriculum for Elementary School, which includes a tour of Faga'alu similar to the tour provided during Coral Reef Task Force meeting in 2012); and • Involve students in a demonstration rain garden installation on campus.

4.0 Faga'alu Village Operations and Maintenance Plan for Local Drainage Infrastructure (Draft)

This section provides a draft Operations and Maintenance (O&M) plan to be further refined and adopted by the Village. Figure 10 is a map showing the locations of key infrastructure to be inspected and maintained under this plan. This map is not intended to represent the entire drainage infrastructure, (i.e., private drainage inlets at the Hospital and the pipe network are not included); merely, it identifies the locations of priority structures for inspection and maintenance.

4.1 Purpose

It is important to conduct routine inspection and maintenance of the structural components of the Village's stormwater drainage system in order to 1) maintain proper drainage function, 2) reduce the transport of trash and sediment to Faga'alu Bay, and 3) maximize the lifespan of existing infrastructure. This plan is to be implemented by the Village of Faga'alu and is intended to assist the American Samoa Department of Public Works (AS DPW) by shifting the majority of inspections and minor maintenance activities to the local community. This plan can also be used as a model for other villages interested in taking on O&M responsibilities.

4.2 Definitions

Catch Basin Typically, a concrete box below a surface drain inlet that collects stormwater runoff and then discharges to an outlet pipe. Depending on the design and depth of the catch basin, sediment and trash can be trapped in the bottom of the structure, which prevents them from being discharged to receiving waters. Therefore, it is important to clean out catch basins to prevent blockages and remove trash and sediment before they are further transported.

Conveyance System The drainage structures, both natural and man-made, which collect and carry surface and stormwater flow. Includes gutters, drainage inlets, pipes, catch basins, manholes, ditches, small drainage courses, and streams.

Culvert Pipe or box structures that allow stream flows to pass under a road.

Drain Inlet Openings along curbs, in parking lots, or in low-lying areas where surface runoff enters catch basins or pipes. Inlets usually are covered with metal grates that allow flows to pass through but prevent tires, chickens, and large debris from entering. Inlets with missing grates can be dangerous to pedestrians and can be easily clogged.

Ditch Narrow man-made channel to convey flow often alongside a road; not a natural stream.

Gutter Curb line along edge of road or parking lot where water collects and is conveyed to drain inlets. Also used to describe a collection system at a roof drip line to convey rain to a downspout or cistern.

Facilities Engineered, structural stormwater practice used to manage runoff rate, volume, water quality, and or recharge. Facilities include ponds, bioretention, porous pavements, green roofs, swales, and infiltration practices, for example. Each facility requires a specialized maintenance plan. There are currently no stormwater facilities in Faga'alu.

Headwall The surrounding concrete support structure where an underground pipe emerges to the surface.

Non-stormwater Discharge Any liquid discharge to the storm drain system that is not derived from rainfall (not including tidal flows).

Maintenance Activities conducted to extend the life cycle and ensure proper operation of existing facilities and drainage infrastructure.

Maintenance Standard Describes the condition when cleaning, repair, or other maintenance is required for a given structure.

Manhole An entrance provided to a drainage structure for the purpose of inspection and cleaning. This may consist of a circular manhole shaft, frame and round cover or an opening into a structure where the top of the structure is at the surface. The opening may be round or rectangular.

Outfall The point of discharge from the manmade storm drain system to the natural drainage system (stream, ocean, etc). Typically is a round pipe, but can also be an open concrete channel or flume.

Pollutant A waste material that contaminates waterways that can include raw sewage and animal feces, oils and grease from cars and cooking, trash, nutrients, chemicals, and excess sediment.

Receiving Waters Any water body receiving stormwater runoff, including surface water and groundwater.

Sediment A naturally occurring material that is broken down by weathering and erosion and transported by wind, water, or other fluids.

Street Waste Liquid and solid waste collected during the maintenance and cleaning of stormwater catch basins, detention/retention ponds, ditches and similar stormwater treatment and conveyance structures.

Stormwater Runoff Portion of rainfall that washes off the surface of parking lots, rooftops, roads, and compacted soils instead of soaking into the ground, evaporating, or being taken up by plants. This water is contaminated by pollutants collecting on these "impervious" surfaces and drains to receiving waters directly o through the storm drain system.

4.3 Administration

The O&M Program is to be overseen by the Faga'alu Mayor, although the Mayor may designate a Program Manager. The Mayor and/or Manager will be responsible for the implementation of the plan including staffing, scheduling of inspections, ensuring completion of maintenance and proper material disposal procedures, recordkeeping, and communicating with ASDPW on significant maintenance issues.

Equipment purchases and storage will be coordinated by the Mayor. Recommended equipment and supplies include:

- Pickup truck for hauling of supplies and trash;
- Notebook/clipboard with inspection report forms, map, and maintenance checklist to document inspection frequency and maintenance conducted;
- Pencils or other writing utensil;
- Camera to document conditions;
- Measuring tape to quantify depth of sediment, standing water, and trash accumulation;
- Trash bags (heavy duty) and/or bins (recycling?);
- (2) Flathead shovels for removing accumulated debris;
- Buckets (for carrying removed sediment);
- Metal crowbar, grate puller, and manhole pick to open lids and covers ;
- Work gloves/with rubber glove inserts (in case of raw sewage or other contaminants);
- Clippers and hand saw for debris removal;
- Traffic cones or safety tape to mark off work area or hazards; and
- Safety clothing and equipment (vests, hard hats ,etc).

A field crew should be staffed by at least two people for conducting inspections and maintenance. Initial staffing for the first year may be volunteer/community service-based; however, after a better sense of the annual level of effort that will be required, funding to support the program should be pursued.

Expenses incurred will include labor costs, supplies and equipment, administrative support, and disposal fees. Capital expenses to repair or replace infrastructure should not be included in the local O&M budget if these currently fall under DPW. Consider grant funding, a line item under DPW's maintenance budget, or fundraising as options to pursue.

4.4 Infrastructure Inventory Map

The infrastructure O&M map included here shows the locations of some of the inlets, catch basins, outfalls, and culverts identified initially for routine inspection and maintenance. This map should be continuously updated based on field crew observations and should include the following information:

- Dimensions, material, and condition of the structure (e.g., 36" round concrete pipe, good condition vs. 24" corrugated metal pipe, corroded and 80% blocked with sediment);
- Location of underground pipe network and flow direction;

- Manhole structures;
- Private drainage infrastructure (hospital parking lot);
- Sanitary sewer system;
- Stormwater facilities (none now, but as they are constructed).

4.5 Inspection and Maintenance Procedures

The Mayor and/or Program Manager should determine the best process for conducting inspections and maintenance. In some jurisdictions, there are too many structures to inspect and maintain in a year's time, so only portions of the system are targeted in a cycle. Given the small size of the Faga'alu Village and limited number of structures, it seems feasible to conduct inspections of the entire system in a single day on a quarterly basis. Table 6 provides some options for consideration.

Table 6. Summary of Inspection and Maintenance Tasks

Tasks	General Description
Inspection	Use infrastructure map to identify locations of all structures to be included in the O&M inspection cycle. Quarterly inspection of all structures is recommended for the first year of the O&M program. Changes to the inspection frequency can be made then on, as appropriate.
Routine Maintenance	Minor maintenance such as trash cleanup, debris removal, and repositioning of covers/grates can be done at the time of inspection.
Repair/replacements	Major repair or other more significant maintenance needs requiring additional equipment or supplies should be documented and reported back to the Mayor or Program Manager. The Mayor or Program Manager will coordinate directly with DPW on addressing the maintenance concern.
Recordkeeping	Inspection and Maintenance Checklist (Figure 11) should be completed by field crews at the time of inspection and should document any actions taken at that time. Checklists should be submitted to and reviewed by the Mayor/Program Manager. Information related to the amount of trash removed should be reported to the Trash Committee members. The Mayor/Program Manager is responsible for maintaining records.
Follow-up	The Mayor/Program Manager is ultimately responsible for ensuring that proper completion of maintenance activities by field crews and/or DPW.

Depending on the condition of the structure at the time of inspection, maintenance action may or may not be required. Maintenance activities can be completed at the time of inspection, or can be scheduled at a later time. Routine maintenance will likely include removal of trash and debris; removal of sediment deposits; and replacing of grates. More significant repairs and/or replacement may be required where the structure has deteriorated, failed, or become a safety issue. Repeated maintenance required at a single structure may require additional actions to be taken further upstream.

Table 7 outlines the inspection frequencies and maintenance activities for different components of the storm drain system. There are no existing stormwater facilities in the Village requiring O&M at this time. If stormwater retrofits are installed or new facilities are constructed, each facility should include an inspection and maintenance plan that can be incorporated herein.

4.6 Waste Disposal Procedures

Street waste (e.g., sediment, debris, and trash) will be generated from the cleaning of catch basins, ditches, pipes, and stormwater facilities. Proper disposal of collected waste is crucial to prevent pollutants from entering the stormwater conveyance system or surface waters and to keep solid wastes from impeding stormwater runoff flow or causing damage to the stormwater system. Procedures for characterization, reuse, and disposal of sediment and debris from maintenance activities need to be consistent with applicable federal and territorial requirements and the requirements of ASPA.

In addition, street waste can contain solids and liquids that are potentially dangerous or hazardous to public health and environment (i.e., ignitable, corrosive, reactive, or toxic). Dangerous wastes may be identified by: unusual color, staining, corrosion, unusual odor, fumes, and oily sheen. Street waste that is suspected of being dangerous waste should not be collected or stored with other street waste. Material in catch basins with obvious contamination should be left in place or segregated until tested. Potentially dangerous waste should be handled and stored separately until a determination as to proper disposal is made.

A plan for the proper disposal of this material will need to be in place prior to collection, particularly if storage and transportation is necessary. In consultation with ASPA, consider the following when developing a plan:

- Solid waste and debris should be stored in appropriate containers or temporary covered storage sites. Material should not be dumped or stored in a location where it will likely re-enter the drainage system or receiving waters.
- Does it make sense to sort items for recycling or for alternative handeling of hazardous materials (e.g. medical supplies, bottles of household chemicals, or used motor oil)?
- Consider if trash should be transported directly to the landfill or if local dumpster capacity is sufficient to accommodate additional load.
- Can vegetative debris be composted in the Village?
- Sediment may be contaminated with pollutants and should not be disposed of in the stream or on beaches. Identify potential locations in the Village watershed where sediment can temporarily stored and then hauled to landfill.

4.7 Non-Stormwater Flows

If during inspections, dry weather flows, suspicious odors, or staining are noticed at outfall pipes or in drainage manholes, then this may be an indication of a non-stormwater discharge. Take notes on the characteristics of flow (e.g., color, soap bubbles, intermittent flow, etc) or odors (e.g., rotten eggs, gasoline) and investigate upstream to see if you can determine a source. Do not compromise your safety or enter into private property. Report all non-stormwater flows to the Program Manager and ultimately to AS-DPW, AS-EPA, or ASPA as appropriate for further investigation. Identification and elimination of the discharge should occur within 30 days of detection.

4.8 Private Structures

The drain inlets at the hospital and quarry were not included in this O&M plan. Consider whether or not to include them, or ask them to develop a similar O&M plan for their drainage system.

4.9 Recordkeeping

A logbook should be kept documenting inspection and maintenance activities. Figure 11 is an example of a simple inspection and maintenance checklist that can be modified as needed. Field inspection crews should submit completed forms to the Mayor/Program Manager. The information provided here can be used by the Watershed Committee for tracking trash cleanup efforts, by the Village to communicate maintenance needs with DPW, and to evaluate trends in sediment and trash loading to receiving waters. Most importantly, the tracking logs can help revise the O&M plan, focus efforts on chronic maintenance needs, and help establish future program budget needs.

4.10 Training

Field crews need to be trained annually on inspection and routine maintenance procedures, including communication, recordkeeping, safety, and disposal procedures. Annual training is recommended, particularly as procedures change, new infrastructure is added, and more experience in village-scale O&M is obtained.

4.11 Updates

This plan should be revised and adopted by the Village. After the first year of implementation, the Village Mayor and/or Program Manager should meet with field crews and DPW to evaluate the effectiveness of the plan and determine what changes need to be made. Minor adjustments to the inventory map and O&M procedures can be made on an as-needed basis. A formal re-evaluation of the plan should be conducted on a 5-year cycle thereafter.

Table 7. Inspection and Maintenance Standards for Stormwater Drainage Infrastructure*

<table>
<tr><th rowspan="2">Inspection Parameters</th><th colspan="2">Conditions When Maintenance Is Needed</th><th rowspan="2">Maintenance Actions</th></tr>
<tr><th>Catch basin/inlets and Manholes</th><th>Pipes, Culverts, and Ditches</th></tr>
<tr><td>Sediment</td><td>• Sediment exceeds 60% of sump depth.
• Sediment depth within 6 inches of the invert of the lowest pipe.</td><td>• Sediment or debris exceeds 20% of pipe diameter or culvert opening
• Accumulated sediment that exceeds 20% of the design depth of the ditch.</td><td>1. Remove sediment with shovels or other equipment (do not remove sediment that is part of the natural stream bottom);
2. Estimate amount removed and record on maintenance log
3. Follow approved sediment disposal procedures</td></tr>
<tr><td>Trash & Debris</td><td>• Trash or debris in front of catch basin opening or blocking inlet by more than10%.
• Trash or debris exceeds 60% of sump depth.
• Trash or debris within 6 inches of the invert of the lowest pipe.
• Trash or debris blocking more than 1/3 of any inlet or outlet pipe.
• Trash and debris blocking more than 20% of grate surface.
• Dead animals or vegetation that generate odors and cause complaints or dangerous gases (e.g., methane).</td><td>• Trash and debris accumulated in pipe or ditch.
• Debris in culvert is blocking flow or likely to cause a blockage
• Debris could impact water or sewer lines under bridge
• Visual evidence of dumping</td><td>1. Collect trash in bags or bins; may need to separate items that are considered hazardous (e.g., medical waste)
2. Remove large woody debris with clippers/saws
3. Record in maintenance log the type and estimated amount of trash/debris collected (e.g., 3 bags collected, mostly plastic bottles and styrofoam containers).
4. Determine likely source of material (e.g., overflow from adjacent dumpster)
5. Follow approved disposal/recycling procedures
6. Mayor or Program Manager to provide trash removal data to Education Awareness Campaign.</td></tr>
<tr><td>Vegetation</td><td>• Vegetation growing across and blocking more than 10% of the grate opening.
• Vegetation growing in inlet/outlet pipe joints that is more than 6” tall.</td><td>• Vegetation reduces movement of water through pipes.
• Excessive vegetation that reduces free movement of water through ditches.</td><td>1. Remove vegetation by hand or trimmer as necessary.
2. Removal of vegetation in the stream channel is not part of infrastructure O&M at this time and should be handled separately in order to preserve the balance between natural stream habitat, buffer protection, and flood conveyance.
3. Dispose of vegetation following approved disposal procedures</td></tr>
<tr><td>Water Quality</td><td colspan="2">• Any evidence of oil, gasoline, contaminants or other pollutants.
• Water flowing in pipes or ditch during dry weather – report as potential illicit discharge concern.</td><td>Report to Mayor or Program Manager who then reports to DPW/AS-EPA</td></tr>
<tr><td>Water Flow</td><td colspan="2">Impeded water flow due to vegetation or sediment</td><td>Remove vegetation or sediment as discussed above</td></tr>
</table>

Table 7. Inspection and Maintenance Standards for Stormwater Drainage Infrastructure*

<table>
<tr><th rowspan="2">Inspection Parameters</th><th colspan="2">Conditions When Maintenance Is Needed</th><th rowspan="2">Maintenance Actions</th></tr>
<tr><th>Catch basin/inlets and Manholes</th><th>Pipes, Culverts, and Ditches</th></tr>
<tr><td>Cover/Frame/ Grate</td><td>• Cover or grate is missing, damaged, or only partially in place.
• One maintenance person cannot remove lid after applying normal lifting pressure.
• Frame separated > 3/4” from top slab.
• Frame not securely attached. Locking mechanism cannot be opened by one maintenance person with proper tools.
• Bolts into frame have < 1/2”of thread.
• Grate with opening > 7/8”.</td><td>N/A</td><td>1. Attempt to correct if possible;
2. Temporarily cover and/or tape-off open manholes or catch basins to prevent pedestrians from falling in; place traffic cones in/or around openings to denote hazard
3. Record information on inspection log and report issue to Mayor or Program Manager
4. Mayor or Program Manager to inspect and follow up with DPW/AS-EPA to replace/repair
5. Follow-up within a week on replacement/repair status.</td></tr>
<tr><td>Structure</td><td>• Top slab with holes > 2 square inches or cracks wider than 1/4”.
• Fractures or cracks in basin walls or bottom.
• Grout at inlet/outlet pipes has separated or cracked wider than ½” and longer than 12”.
• Soil is entering the catch basin through cracks in the structure.
• Settlement has created a safety, function, or design problem.
• Field inspector judges that structure is unsound.
• Inlet or outlet piping damaged or broken and in need of repair.</td><td>• Damage or rust is causing more than 50% deterioration to any part of pipe or headwall.
• Any dent that decreases the flow area by more than 20% or puncture that impacts performance.
• Debris barrier/trash rack is missing, bent more than 3 inches, corroded, or not attached to pipe.</td><td rowspan="2">1. Record information on inspection log and report issue to Mayor or Program Manager
2. Mayor or Program Manager to verify and follow up with DPW/AS-EPA on repair/replacement plan
3. Follow-up within 30 days on replacement/repair status.</td></tr>
<tr><td>Other</td><td>• Standing water for more than 72 hours in areas accessible to mosquitoes.
• Manhole access ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.</td><td>• Standing water in the pipe or swale between storm events.
• Erosion damage over 2”deep where cause is still present or there is potential for continued erosion (e.g. in ditch bottom, culvert revetments, or at outfalls.</td></tr>
<tr><td>Could Not Locate</td><td colspan="2">Field inspectors are unable to locate the catch basin or manhole.</td><td>1. Check back with Mayor or Program Manager
2. Ask DPW to field verify or update map</td></tr>
</table>

*Adapted from the 2011 Douglas County, Washington Stormwater Pollution Prevention Operations and Maintenance Plan.

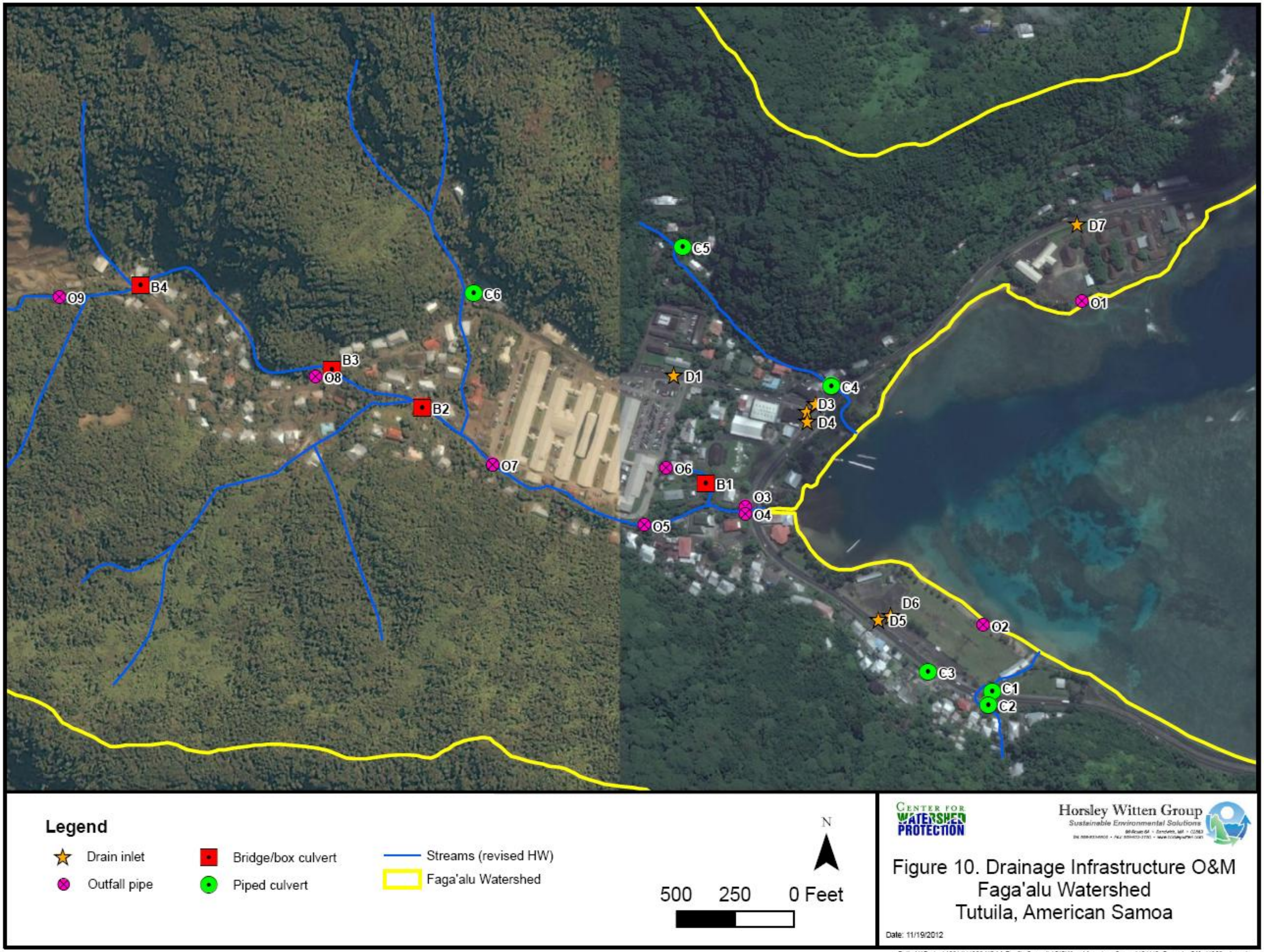

Figure 10. Drainage Infrastructure O&M
Faga'alu Watershed
Tutuila, American Samoa

Date: 11/19/2012

Path: H:\Projects\2011\11069 NOAA Pacific Capacity\GIS\Maps\American Samoa\121113_Fagaalu_OM_11069eck.mxd

Figure 11. Example Inspection and Maintenance Checklist

Faga'alu Village Stormwater Drainage Infrastructure Inspection and Maintenance Checklist

Date of Inspection: ____________________ Field Inspector(s): ____

Current Weather: _____________________ Rain (inches): In Last 24 hrs:_____________

Reason for Inspection: ☐ regularly scheduled ☐ complaint response

Site/Structure ID (see map)	Maintenance Needed (describe)	Maintenance Completed (describe/date)	Quantity Sed./trash/ debris removed	Follow-up needed
				☐ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No
				☐ Yes ☐ No

Mayor/Program Manager Has Reviewed This Inspection Form: _____________________________ Signature ____________Date

5.0 Implementation Schedule

This section presents a preliminary implementation schedule for allocating efforts over the next five years and makes suggestions on methods to evaluate progress and success of implementation activities over time. The complete implementation of watershed plan recommendations can take decades, even in a small watershed like Faga'alu. Over time, significant changes will likely occur in conditions on the ground, local priorities, funding opportunities, and the participation of stakeholder and key implementation partners. The failure to track changes and update watershed plans on approximately a five year cycle can render plans obsolete.

In order to advance implementation, at least in the short-term, it is advantageous to establish a preliminary schedule that includes an estimated budget and assigned roles for meeting each of the management recommendations outlined in the watershed plan and in this supplement. The schedule presented in Table 8 builds upon information presented in the watershed plan, but is preliminary in nature and should be modified as needed by the Village. Not all actions and management recommendations identified are included in this early implementation schedule. It should be noted that implementation is already underway on a number of priority recommendations (e.g., education campaign, watershed signage, piggery conversion, quarry corrective actions).

Evaluating progress towards achieving the overarching watershed goals is critical to determining the success of a watershed planning effort and to secure additional funding. A formal tracking and monitoring program should include:

- **Annual progress report**—this forces documentation of implementation actions completed that year, a budget review for the following year, and an update to plan priorities as necessary. Annual reporting also provides an opportunity to brief agency staff, elected officials, funders, and the public on watershed management progress. This effort can help improve communication with implementation partners, keep watershed activities on the front burner as capital budgets and other agency priorities evolve, and keep watershed restoration in the public conscience.
- **Monitoring plan**—develop a scientifically-sound monitoring plan for establishing baseline conditions before restoration activities are in place, and to measure changes over time. Baseline stream turbidity has been established and efforts by San Diego State University and others to continue in stream monitoring are ongoing. This data will be an important part of the watershed story in Faga'alu. The monitoring plan should also include quantification by the Village of trash collected as part of O&M and quarterly trash cleanup activities. AS-EPA water quality monitoring for bacteria and nutrients in the bay is the third monitoring component.
- **Performance Metrics**—develop a list of performance metrics to be used to evaluate progress towards meeting each of the watershed goals. Examples include awareness surveys as part of the watershed education campaign.

Table 12. Preliminary Implementation Schedule over Next Five Years*

Action**	Lead	Implementation Year and Planning Level Cost Estimate (thousands of $)***				
		1	2	3	4	5
1.2-1.8 Implement Education and Awareness Campaign. Target two education topics per year with printed materials/hands on activity (e.g., tree planting, storm drain stenciling)	Faga'alu Committee, AS-EPA	$5 trash and recycling	$5 fisheries and stormwater	$5 trees and erosion	$5 res/ com. pollution prevention	$5 Repeat or new topic
1.6, 2.8, 3.6 Quarterly trash clean ups; bins; biannual hazardous waste collection. Report amount collected and summarize as part of annual watershed report.	Trash committees	$5 startup	$2.5	$2.5	$2.5	$2.5
Adopt and implement Village-scale infrastructure O&M plan with quarterly inspections routine maintenance; mapping updates	Village Mayor	$2.5 routine	$2.5 routine	$10 upgrades	$2.5 routine	$2.5 routine
Implement, enforce, and fund Quarry Corrective Action Plan	Samoa Maritime, AS-EPA/ASDOC, NFWF	$200 construction	$5 Annual inspection/ maintenance	$5	$5	$5
Sewer line extension and road improvement	ASPA	$25 planning	$400 construction	--	--	--
Install two demonstration rain gardens/bioretention	AS-EPA	--	$25 Matafao Elementary	--	$25 Hospital	--
Restore fish passage and demonstrate improved bridge/culvert design by installing low flow channel	AS Community College	$5k in-stream fauna baseline assessment	$5-$10	$2.5 in-stream monitoring	$2.5 in-stream monitoring	$2.5 in-stream monitoring
8.2 Establish Marine Protected Area in Faga'alu Bay	Village Mayor, DMWR, NOAA	--	$10	$25	$5	$5
Annual Report and Monitoring	AS-EPA, SDSU, Trash Com., Mayor	$5	$5	$5	$5	$5
Annual Total (rounded to nearest $5,000)		**$250**	**$465**	**$55**	**$50**	**$30**
Total (in thousands)						**$850**

* Does not encompass all the recommended actions, only a subset. **Numbering corresponds to Strategic Action in existing watershed plan.
*** Actual costs are dependent on many factors and may vary significantly; readers should use planning level costs for a comparison of implementation items.

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Appendix A

Structural Restoration Project Opportunities in the Faga'alu Watershed

1. New Bridge—Create a Low Flow Channel

Site Description

Recent repair activities at the main bridge crossing Faga'alu stream in 2011-2012 include the replacement of the pipe culverts with a large box culvert to better accommodate high flows and to reduce blockage by debris. The channel has been widened and channelized with concrete at this location. This design results in a very shallow base flow (less than 2 inch depth), which likely impedes the natural migration of aquatic fish and invertebrate communities.

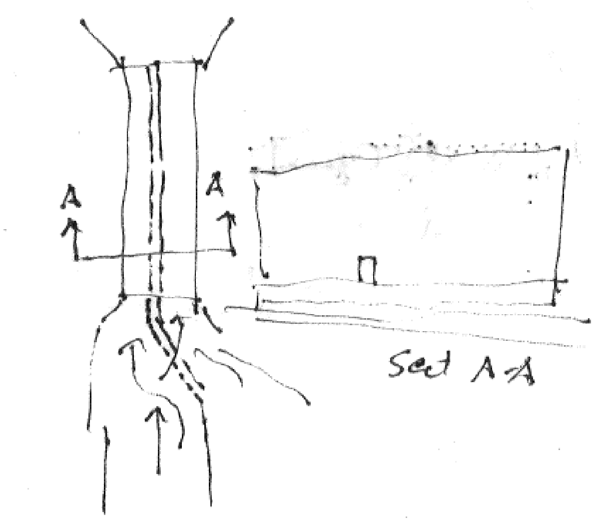
Many, if not all, of the freshwater snails, shrimps, and fishes found in the streams in American Samoa spend a portion of their lives in the ocean (American Samoa Community College, 2009). Culverts and dams can prevent access to freshwater habitats for a number of species migrating upstream depending on the length, slope, and height of the structure, and the resulting depth and velocity of water flowing through the structure.

New and retrofitted stream crossing designs in the US mainland (especially the Pacific Northwest) have evolved over the last few decades to better address fish/invertebrate passage using techniques such as low flow channels, baffles, fish ladders, and open bottom culverts.

Proposed Concept

This structure has been newly installed; therefore a simple, inexpensive design is recommended. The concept involves the addition of a narrow concrete separator wall or berm (approximately 4 inches wide and 6 inches high) along the channel bottom to concentrate low flows on one side of the channel (Figure 1A and 1B). High flows can overtop the wall in order to utilize the full width of the channel. Variations in the wall thickness or the addition of baffles can provide additional diversity in the low flow regime to support various aquatic fauna. Temporary stream diversion during the construction to create a dry work area could be accomplished using sandbags or piped bypasses.

Figure 1A. Installation of 6-inch concrete berm to concentrate low flows to one side of channel. Flows higher than separator wall can spread across entire channel width.



Plan View **Cross-section**

Figure 1B. Plan view and cross-sectional sketch of simple concept design.

New projects in the future, however, could be designed differently (see Figure 1C).

Figure 1C. Photos of various alternatives to create low flow channels using separator walls (A, C, D) coupled with baffle devices (A,D,F, and G); low flow channel within a larger high flow channel (B); and using open bottom/arched culverts to allow for natural bottom habitat.

2. Main Road—Community Bioretention

Map showing location of proposed bioretention (blue polygon in yellow circle) and drainage area to practice (red dotted line).

Site Description

Currently, runoff from approximately 2.1 acres and 850 linear feet of roadway drain into a concrete gutter along the road to a discharge location upstream of the new bridge. The roadway is heavily travelled by trucks serving the quarry at the upper end of the drainage, and stormwater pollutants (e.g., sediment, oils, metals) are discharging directly into the stream. A small grassed area uphill of the concrete channel could be used to provide some water quality treatment for small storms (Figure 2A). In addition, the gravel parking pad at the bridge is showing signs of erosion (Figure 2B).

Proposed Concept

Modify the concrete gutter/curb with either a flow diversion weir and/or curb to direct small storm flows into a bioretention cell. Larger flows can bypass the diversion and continue to the existing outfall location. Runoff in the bioretention will either infiltrate or be taken up by plants. Excess runoff (if any) can overflow the bioretention either back into the road gutter or through an underdrain system or stabilized spillway into the stream. A small forebay could be installed to provide pretreatment for grit and sand. This site is a great opportunity to demonstrate a community stormwater facility in a highly visible location.

Practice Sizing/Design Considerations

The sizing of bioretention is based on the drainage area, available surface area, and a ponding depth above the soil media. The target size for a bioretention cell is based on managing the first two (2) inches of runoff from impervious surfaces; in this case, the available practice area estimated from the initial site visit is not quite adequate to manage this total volume. However, significant treatment is possible.

Figure 2A. Potential location for community bioretention to capture and treat a portion of the runoff conveyed in existing concrete roadside swale.

A curb-cut is required to convey the gutter flow in the roadway into the bioretention cell. This can be as simple as removing the back of the curb and leaving an opening (approximately 4 ft long), or a small diversion (concrete berm in the gutter pan) can be added to force the runoff to divert into the curb cut opening. The design of the cell includes a ponding depth of 9-inches, and should therefore be situated such that when the ponding volume is full, the excess flow bypasses the curb-cut opening in the gutter pan and continues down the street.

Pollutant Removal

Bioretention facilities are assumed to remove 90% TSS; 30% TP; 55% TN; and 70% bacteria (RI Manual, 2010). This assumes the full design treatment volume is provided. If available space is limited, the annual load reductions would be reduced.

Next Steps

- Contact the Village Mayor and adjacent residents and determine if this retrofit is a favorable option in this location;
- Determine the site utilities and other potential conflicts. Complete a topographic survey of the area;
- A soil investigation should guide the excavation so as to maximize opportunities for infiltration. If the soils do not infiltrate, an underdrain should be included in the design, and located to safely outfall into the adjacent stream with minimal disturbance to the stream bank;
- The available practice area was estimated to be 870 sf. It should be expected that careful field engineering will allow the practice area to be expanded within the available space. Care should be taken to avoid impacting existing mature vegetation, while also avoiding the stream bank.

Figure 2B. Existing concrete swale discharges directly to stream. There is additional evidence of flow paths eroding gravel parking pad.

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
2	2.1	18	2,744	1,190	870

*Design Treatment Volume: Tv (cf) = (2”)(I)/12; I = impervious area (sf)

*Practice Area Required is calculated based on practice-specific design assumptions (e.g. depth of filter bed, coefficient of permeability, depth of ponding water, and drain time).

*Practice Area Available is estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

3. Culvert Replacement—Reduce flooding

Site Description

Approximately 500 feet down-slope from the new bridge and approximately 300 feet uphill from the upper driveway into the hospital, an unnamed tributary runs parallel to and then crosses under a local access road through three culverts (a large diameter culvert and two smaller culverts – Figure 3A) before crossing under the main roadway (a rectangular culvert – Figure 3B) that connects the Faga'alu Village to Hwy 001. This unnamed tributary has an approximate drainage area of 38 acres. The culverts that cross under the access road are not adequate for the larger storm flows, which reportedly overtops the access road and is conveyed down the main roadway causing erosion and safety concerns.

Figure 3A. Looking downstream towards the upper end of the three-pipe culvert.

Flooding at roadway culverts can be caused by inadequately sized culverts and/or restrictions or blockages caused by debris. Inadequately sized culverts may be the result of changes in land cover and channel conveyances in the upstream watershed. Converting land cover from woods to residential uses will increase the volume of runoff, and creating conveyance channels to carry the runoff through (or around) these new residential areas increase the volume and peak rate of flow of the runoff delivered to the downstream culvert. Hence, a culvert that may have been sized properly when initially installed can be undersized given the new development.

The culverts at this location may not be large enough to convey the desired design storm runoff. Or, the small diameter of the two additional pipes may be getting clogged by the debris being washed down through the forested watershed above the culverts, reducing the overall capacity even further.

Figure 3B – Looking downstream at rectangular culvert under main road (outlet of existing culverts hidden by vegetation – no picture available).

Proposed Concept

The proposed retrofit involves replacing the existing culverts with an adequately sized and box culvert and headwall.

Practice Sizing/Design Considerations

The capacity of the rectangular box culvert under the main roadway is reportedly adequate (anecdotal evidence from Mayor and other residents). Therefore, it is possible that the most efficient and cost effective solution is to construct a similarly sized box culvert under the access road.

Based on an estimate of the drainage area (38 acres, wooded, steep terrain) and a designated rain fall design intensity (estimated to be 6 inches/hour), the design peak discharge can be estimated using the Rational Method equation:

$$Q=CIA$$

where Q = peak discharge, C=runoff coefficient (Band 2-steep forested) = 0.7, and A = contributing drainage area = 38 ac.

Q = (0.7)*(6”/hr)*(38 ac) = 160 cfs;

Assumptions:
Approximately 5 ft head from channel invert to road;

Preliminary Sizing:

Option 1: 6’ x 4’ rectangular culvert at 0.005 ft/ft (minimum); depth of flow ~ 3.5 ft. (FHWA Rectangular Channel Flow Chart).

Option 2: Twin 42” concrete (or smooth wall plastic) at 0.01 ft/ft; depth of flow~2.9 ft. (FHWA Circular Pipe Flow Chart)

Pollutant Removal

Pollutant removal is not provided by this retrofit. The benefits of this retrofit are measured primarily in terms of infrastructure protection (roadway embankment and pavement failure from excessive scour).

Next Steps

- Verify dimensions of existing rectangular culvert under main road.
- Verify slope of the channel through the road cross section.
- Coordinate design criteria with American Samoa DPW.

4. Hospital—Disconnecting Impervious Cover

Site Description

The LBJ Hospital has over 8.5 acres of impervious cover consisting of building rooftops, parking lots, and concrete walkways that drain directly to the stream via a system of drain inlets, catch basins, and drainage pipes. Currently there are no stormwater management practices at the hospital to clean or infiltrate runoff, and there are a number of opportunities for retrofitting. Also, the hospital has high visibility and education value for American Samoa demonstration projects.

Proposed Concepts

There were 12 retrofits identified at this site (see Table) including bioretention, planter boxes, and porous pavement. Three were selected to detail here due to their high visibility as a retrofit demonstration project, feasibility, and relatively inexpensive cost of construction:

4A. A raingarden/bioretention is proposed at the corner administrative offices in the existing grass area (Figure 4A). The drainage area consists of rooftops and a driveway area and includes a concrete channel that directs runoff into an existing catch basin. This catch basin discharges to the hospital's stormwater drainage system and could be used as the bioretention's overflow structure. Potential conflicts include a utility pole. This practice could be easily installed and is near the roadway and parking lot entrance for high visibility.

4D. A bioretention is proposed within the grassy area at the hospital entrance (Figure 4D). The surrounding rooftops drain to concrete channels along the walkways. Runoff in the channels is directed into shallow pipes that pipe discharge underground into the yard inlet in the center of the grassy area. A shallow excavation of the grassed area would allow flows from the concrete channel outlet pipe to discharge to the bioretention surface. The existing yard inlet could be used as an overflow structure. There are two concrete structures located on the south side of the grassy area, which appear to be old rainwater capture systems. There were no visible utilities or observed conflicts.

Map showing location of proposed rain gardens/bioretention practices (blue polygons) and porous pavers (orange). Drainage areas to the practices are denoted by red dotted lines.

Figure 4A. Proposed location for small bioretention near the administrative building.

4F. A stormwater planter is proposed along the front side of the chapel to collect rooftop runoff. A stormwater planter is a raised plant bed containing engineered soils and vegetation that filter and slow down runoff. The planter container can be decorated to fit in with the American Samoa culture and the hospital surroundings. The overflow and underdrain can outlet to the existing storm drain near the adjacent downspout.

Figure 4D. Proposed location for small bioretention between building rows. An inlet is in the middle of the area (red arrow).

Practice Sizing/Design Considerations

The target size for the practices is based on managing the first two (2) inches of runoff from impervious surfaces; in this case, the available practice areas estimated from the initial site visit provide enough space for the target total volume for all practices except 4C and 4I. The table below summarizes the sizing calculations for all 12 potential projects, however, porous pavement sizing is typically a simple 1:1 ratio, assuming depth of bed material and underdrain structures can be adjusted to meet target volumes. The bioretention sizing assumes a 6-inch ponding depth. If rain gardens are used instead, a larger surface area will be needed.

Figure 4F. Location of potential planter boxes to enhance aesthetics of the chapel and reduce runoff contribution from rooftop. Overflow can tie into existing drain near adjacent downspout or at sidewalk.

Pollutant Removal

Bioretention facilities are assumed to remove 90% TSS; 30% TP; 55% TN; and 70% bacteria (RI Manual, 2010). Stormwater planters are assumed to remove 40% TP & 25% TN (CWP).

Next Steps

The following next steps can facilitate practice implementation:

- Contact the hospital and determine if any of these retrofits are a favorable option and discuss maintenance requirements;
- Refine drainage areas and collect more information on location and depth of utilities and drainage structures;
- Develop engineer designs that are specified to meet the appropriate water quality volume; and
- Develop a maintenance agreement and educational signage.

Figure 4C. Not described here, but another location is in the interior courtyard using existing drainage infrastructure for conveying flows in and out of practice.

Summary of sizing calculations for proposed retrofits at the Hospital.

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
4A bio	0.30	30	653	297	870
4B bio	0.06	80	348	158	430
4C bio	0.32	90	2091	950	870
4D bio	0.32	90	2091	950	1,300
4E porous pavers	0.09	100	--	450	450
4E bio	0.31	80	1800	818	870
4F bio	0.12	100	871	1300	1300
4G Planter	0.14	80	813	370	450
4H bio	0.35	90	2287	1040	870
4I bio	0.16	90	1045	475	440
4J porous pavers	0.36	100	--	15,680	15,680
4K porous pavers	0.30	100	--	13,070	13,070

* Design Treatment Volume: Tv (cf) = (2”)(I)/12; I = impervious area (sf)
* Practice Area Required is calculated based on practice-specific design assumptions (e.g. depth of filter bed, coefficient of permeability, depth of ponding water, and drain time).
* Practice Area Available is estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

5. Church—Dry swale

Site Description

The Church has approximately a 0.87 acre contributing drainage area (60% impervious cover) consisting of building rooftops, a gravel parking lot, a cemetery, and roadway. Drainage for the site is routed to an existing catch basin that runs across the highway and into Pago Pago Bay (Figure 5A). Currently there are no stormwater treatment practices at the church. The church is near Hwy 001 at the Faga'alu Village center and therefore a good opportunity for water quality improvements. Educational signage could be installed at the practice location to inform visitors of the functions and values of the control measure, and to raise awareness of potential impacts from stormwater on Pago Pogo Bay.

Map showing location of proposed dry swale (blue polygon) and drainage area to practice (red dotted line).

Proposed Concepts

The proposed retrofit is a dry swale with an underdrain system. A new catch basin structure will collect the dry swale overflow and underdrain to direct flows to the existing drainage network. Potential conflicts include parking demand for the church, and adequate space between Hwy 001 and the church driveway. Access to the practice is good and because it is near a major road and the church it offers high visibility.

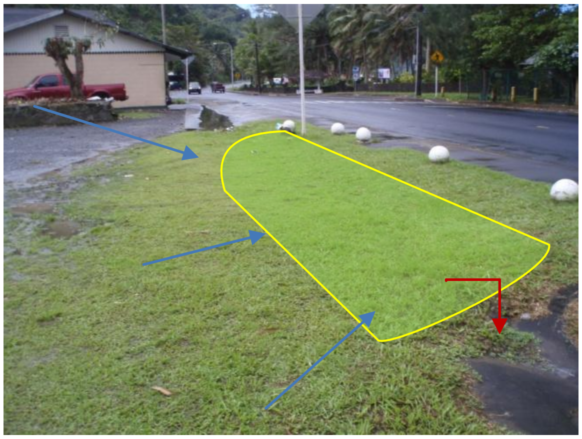


Figure 5A. A dry swale with vegetation and underdrain is proposed in the grassy area of the church. Outlet is shown with red arrow.

Practice Sizing/Design Considerations

Similar to bioretention, the sizing of the dry swale is based on the drainage area, available surface area, and the ponding depth above the soil media. The target size for a dry swale is based on managing the first two (2) inches of runoff from impervious surfaces; in this case, the available practice area estimated from the initial site visit provides only enough space for about half of this target total volume. However, some treatment is possible, and in terms of priority, the potential pollutant loading from the contributing area is moderate.

A paved inflow flume would be required to convey flows into the dry swale.

Pollutant Removal

Dry swales are assumed to remove 90% TSS; 30% TP; 55% TN; and 70% bacteria (RI Manual, 2010). This assumes the full design treatment volume is provided. If available space is limited, the annual load reductions would be reduced.

Next Steps

- Contact the church and determine if this retrofit is a favorable option and whether the parking demand during church services would limit available space;
- Determine the site utilities and other potential conflicts. Complete a topographic survey of the area;
- A soil test pit should be conducted to verify subsurface conditions and depth to groundwater. If the soils will allow for infiltration, the underdrain could be elevated.
- The available practice area was estimated to be approximately 870 sf. It should be expected that careful field engineering will allow the practice area to be expanded within the available space.

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
5	0.87	60	3,790	1,650	870

*Design Treatment Volume: Tv (cf) = (2”)(I)/12; I = impervious area (sf)

*Practice Area Required is calculated based on practice-specific design assumptions (e.g. depth of filter bed, coefficient of permeability, depth of ponding water, and drain time).

*Practice Area Available is estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

6. Fanu Park—Gravel Wetlands

Site Description

The drainage area to the Fanu Park is approximately 3.4 acres, and includes the main road through Faga'alu Village and part of Hwy 001, which includes both residential and commercial/retail uses. Impervious cover is estimated to be approximately 50% of the total area. Drainage flows from the main road, beginning just east from the hospital entrance, to the intersection with Hwy 001 into a set of drainage inlets which then flows by a piped system into a tidal creek in Fanu Park. An open channel also flows behind the residences and collects runoff from a significant drainage area extending up behind the Dept of Health to the ridge-line of the Faga'alu watershed itself, an area of over 30 acres (management of this area is not proposed).

Map showing location of proposed gravel wetland (blue polygon) and drainage area to practice (red dotted line).

Proposed Concepts

Drainage from the roadway would be captured by the installation of a diversion manhole and pipe (in the "Island Flowers" parking lot) to convey runoff to a proposed gravel-based wetland located on the opposite side (east) of Hwy 001. The gravel-based wetland would be designed to encompass the existing channelized tidal creek. Flow from the 30+ acre watershed would be conveyed around the gravel wetland to outlet directly into Pago Pago Bay.

Figure 6A: Gravel wetland area, inflow diversion from new pipe across Hwy 001 shown in red arrow, bypass of flow from existing channel in orange.

Practice Sizing/Design Considerations

The gravel wetland would be sized to manage the first two (2) inches of runoff from the up-gradient impervious area. The available surface area in this location is approximately 3,050 SF which substantially exceeds the minimum surface area recommended for effective treatment. Unfortunately, given the elevation of the diversion, relative to sea level, there is only about three feet available for storage in a permanent pool; this equates to about half the target volume for water quality treatment. Again, some treatment is possible, and in terms of priority, the potential pollutant loading from the contributing area is moderate to high.

Pollutant Removal

Gravel wetlands are assumed to remove 86% TSS; 53% TP; 55% TN; and 85% bacteria (RI

Manual, 2010). This assumes the full design treatment volume is provided. If available space is limited, the annual load reductions would be reduced.

Next steps

- Contact the Fanu family to determine if this retrofit is a favorable option in this location;
- Determine the site utilities and other potential conflicts. Complete a topographic survey of the area;
- Conduct soil test pits to verify subsurface conditions and depth to groundwater.
- The available practice area was estimated to be approximately 3,050 sf. It should be expected that careful field engineering may allow the practice area to be expanded within the available space.

Figure 6B. Impacted stream section through park (top photo) and trash collected at upstream end of culvert (bottom).

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
6	3.4	50	12,200	520	3,050

*Design Treatment Volume: Tv (cf) = (2”)(I)/12; I = impervious area (sf)

*Practice Area Required is calculated based on practice-specific design assumptions.

*Practice Area Available is estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

7. Department of Health—Stormwater Retrofits

Site Description

The Health Center across from the LBJ Hospital is a health services campus ~1.5 acres (70% impervious cover) consisting of terraced buildings benched into a gently sloping hillside. Drainage for most of the site is routed from parking lots and rooftops in open concrete channels. Runoff is ultimately discharged to the main Village road in front of the campus, or to local access road to the east (Site #8 that includes road and sewer improvements).

Proposed Concept

There are four proposed practices in three drainage areas:

A. A combination of permeable pavement in portions of the parking lot and bioretention at the lower (south-east) corner (photo 7A). The drainage area consists of rooftop and paved parking and a small inlet that discharges at the bottom of a retaining wall in the southeast corner of the sub-area. This inlet location will serve to collect the bioretention overflow and underdrain. The inlet discharges at the toe of the retaining wall. The outlet pipe has been damaged from previous maintenance or construction, and will need to be repaired, regardless of the retrofit.

Also, this south east corner has been identified for possible expansion of one of the adjacent offices (Tuberculosis Clinic) which may require complete reworking of this drainage, so final location and design of the proposed bioretention basin must be coordinated with the expansion plans. The outlet of this retrofit area currently drains to the adjacent access road on the eastern side of the site (possibly proposed for re-construction). As an alternative, the outlet can be redirected to wrap around the corner of the building and directed to Retrofit B.

Map showing proposed practice locations (blue) and the areas draining to them (red line).

B. Bioretention within the grass area between the two buildings (photo 7B). The bioretention will capture the entire rooftop of the uphill building (north), as well as any overflow from Retrofit A (if not directed to the street). The discharge of this retrofit will be to the southeast corner of the green area at the corner of the next building. This location is complicated by a partially exposed sewer connection that is currently blocking the flow of runoff, causing erosion and undercutting the building foundation and possibly the sewer connection itself (photo 7C). This outfall will require careful design in order to protect both the building and sewer connection. Ideally this flow should be directed to the adjacent road improvements and the sewer connection properly protected.

C. Capture the runoff from the main driveway and the adjacent rooftops on the western side of the campus and treat it in a bioretention area in the front grass area between the building and the road. Install a small trench drain or asphalt berm (speed bump) diagonally across the driveway to divert runoff from the driveway to the grass area. The bioretention will discharge to the adjacent roadway drainage.

Figure 7A. Proposed location for small bioretention in upper parking lot. A portion of the parking lot is also proposed to be converted to permeable pavers.

Practice Sizing/Design Considerations

A. The area of permeable pavement and bioretention should be balanced as the there is more available space to accommodate the permeable pavement than there is for the bioretention cell. Ideally, the lower portion of the parking area should be retrofit with grass pavers, and the bioretention is sized to treat the rest of the drainage area. Under our initial scenario, there is not quite enough space for a bioretention with 6-inch ponding depth; however, the balance between porous pavement and bioretention could be adjusted.

B. This area is very simple in concept. The entire grass area is potentially available for a bioretention cell. The slope of the ground may require some grading to capture the entire roof of the upper building. The difficulty is in the outlet where the sanitary sewer connection is exposed (photo 7B). The improvements to the adjacent access road, and improvements to the sewer connection should be coordinated with the drainage improvements

Figure 7B. Proposed location for small bioretention between building rows. Exposed sanitary sewer line and stormwater converging in one location at the outlet of Area B.

C. Area C also includes a significant amount of room to implement any number of practices. The primary sources of runoff include the long driveway along the western side of the campus, and the rooftop of the adjacent building. The simplest approach could be to ensure the driveway and rooftop runoff enters the grass area as sheet flow and utilize the grass area as a vegetated filter strip. Alternatively, a full bioretention cell can be constructed.

Pollutant Removal

Bioretention facilities are assumed to remove 90% TSS; 30% TP; 55% TN; and 70% bacteria (RI Manual, 2010). Permeable Pavers are assumed to remove 90% TSS; 40% TP; 40% TN; and 95% bacteria (RI Manual, 2010).

Figure 7C. Proposed location for small bioretention to capture runoff from drive aisle. .

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
$7A_{pavers}$	0.13	100	944	4,720	6,000
$7A_{bio}$	0.30	80	1742	800	700
7B	0.19	30	414	200	1,000
7C	0.16	70	813	400	2,100

* Design Treatment Volume: Tv (cf) = (2")(I)/12; I = impervious area (sf).

*Practice Area Required is calculated based on number of practice-specific design factors (e.g. depth of filter bed, coefficient of permeability, depth of ponding water, and drain time). The bioretention facilities assume 2.5 ft filter bed, 1ft/day permeability, and 6-inch ponding depth. Slightly larger footprints may be needed if opting for no underdrain system. Permeable pavers assume 6-inch gravel bed, 0.4 porosity, and effective depth of 0.2 ft.

*Practice Area Available is estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

Next Steps

- Coordinating with the other facility improvements (such as the tuberculosis clinic, sanitary sewer connection) will help in leveraging construction dollars since some of the improvements are likely beneficial to the stormwater retrofit.
- A topographic survey will provide more detailed information as to the area available for Area B. The key information is the slope and extent of grading required to implement a bioretention filter with a flat ponding surface.
- A survey of the existing soils should guide the excavation so as to maximize opportunities for infiltration. If the soils do not infiltrate, an underdrain should be included in the design, and located to safely outfall into adjacent drainage systems or surface sheet flow.
- Design Construction plans for the stormwater retrofit should be developed and made available to the facility for implementation as funding or other projects allow.

10. Matafao Elementary School—Rain gardens

Site Description

The Matafao Elementary School parcel is located shoreward of the coastal road, is approximately 2 to 3 acres in size, and consists of 10 small classroom buildings and one large newly constructed classroom building interconnected with sidewalks and green space. There are some large trees protected with tree-well knee walls. Reportedly, standing water is a chronic problem in the interior yard. There are numerous potential retrofit opportunities on campus.

Map depicting location of proposed retrofit (blue polygon) and estimated drainage area (red dashed line).

Proposed Concepts

The implementation of stormwater retrofits on a school site is ideal in terms of an educational opportunity for the students, teachers, and parents. Two locations were identified as potential retrofit sites:

10A This retrofit includes the installation of bioretention cells in the green space bounded by the network of sidewalks serving the small classroom buildings. Figure 10A shows the general layout of the proposed bioretention. It is expected that this configuration could be duplicated with a mirror image on the other side of the sidewalk.

The areas bounded by the sidewalks are reportedly subject to frequent stormwater flooding. No drainage improvements were included with the construction of the new sidewalks and school building. Therefore, a critical need for the school, and an essential element of this retrofit, is the installation of new drainage infrastructure. The storm drain pipe outfall shown in Figure 10B appears to be the downstream end of a drainage pipe that runs through the school site from the coastal road to the bay. It also appears that the upper portion of this pipe may run beneath a large tree, which may have blocked or damaged the

Figure 10A. Looking east at 13-A bioretention cell locations (potential installations on both sides of sidewalk) and partial view of contributing drainage area.

pipe. However, if the downstream half of the drainage pipe is operational, it can serve as an outlet for the retrofits as well as drainage relief during large (flood producing) rain events. Reconstruction of this pipe could be done in conjunction with a proposed shoreline stabilization project (see project # 11).

10B. This retrofit is located on the eastern side of the campus and is located in an area that exhibits signs of standing water during rain events (Figure 10C). The area receives runoff from half of the new school building roof, as well as from two adjacent small classroom buildings. There is no apparent outlet location for an underdrain, other than a long run of pipe (approximately 80 feet under the adjacent parking lot) to the shoreline. An alternative is to create a shallow bioretention ponding area (similar to current conditions – with the addition of a more defined ponding zone, and water loving plants), with a defined overland flow outlet towards the parking area and shoreline.

Retrofits at this site would help accomplish multiple goals:

1. Provide watershed education and outreach opportunity to engage schools across the island in watershed restoration;
2. Improve the water quality of the runoff;
3. Improve the aesthetics of the area (either shade or excessive ponding has stunted growth of grass or any groundcover vegetation); and
4. Improve reported flooding issues due to lack of drainage infrastructure.

Practice Sizing/Design Considerations

The practices are sized to manage the first 2 inches of rain (see table below). The area available for each retrofit is sufficient to meet this design target assuming a ponding depth of 6 inches.

Figure 10B. Outfall of existing/historic storm drainage pipe

Pollutant Removal

Bioretention facilities are assumed to remove 90% TSS; 30% TP; 55% TN; and 70% bacteria (RI Manual, 2010).

Next steps

- Verify the permeability of the soils and the depth to water table in both retrofit locations.
- Drainage System Investigation of the existing drainage pipe that outfalls at the shore line adjacent to the basketball courts is a critical part to the success of retrofit 13A. If the pipe is functional then the invert at the relative area of the retrofit will establish the available depth of bioretention soil media and underdrain.
- This is a high traffic area. Design should be coordinated with school officials and on-site maintenance/landscaping personnel to ensure low maintenance vegetation.
- Interpretive signage and lesson plans for utilizing the bioretention cells should be included in the design.

Figure 10C. Broken panorama of location of bioretention location 10B.

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
10A	0.1	60	436	200	600
10B	0.25	50	908	400	1,260

* Design Treatment Volume: Tv (cf) = (2")(I)/12; I = impervious area (sf)

*Practice Area Required is calculated based on practice-specific design assumptions (e.g. depth of filter bed, coefficient of permeability, depth of ponding water, and drain time). These retrofits were sized as a bioretention facilities, slightly larger footprints would be needed if opting for a raingarden with no underdrain system.

*Practice Area Available is estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

12. Road Right-of-Way—Bioretention/bioswale

Site Description

Just south of Matafao Elementary School, there is a small grassed area in the Hwy 001right-of-way (ROW). The area is compacted soils, appears to be used for parking of vans and is within a portion of the sanitary sewer easement. This section of shoreline is the transition point between a rock stabilized seawall and an eroding stretch of shoreline behind the Elementary School. This location could serve as a demonstration site for showcasing how to integrate drainage improvements with shoreline stabilization projects or within the narrow road ROW.

Proposed Concepts

The concept is to install a bioretention facility in conjunction with a shoreline stabilization project. Install a formal paved flume at the road interface to convey flows to a bioretention facility or into a linear vegetated swale system parallel to the top of the coastal bank. This site is highly visible and could be designed to incorporate a picnic table and/or overlook bench.

Practice Sizing/Design Considerations

The practices are sized to manage the first 2 inches of rain (see table below). The area available for each retrofit is sufficient to meet this design target assuming a ponding depth of 6 inches.

Map depicting the location of proposed bioretention (blue) and area draining to it (red line).

Pollutant Removal

Bioretention facilities are assumed to remove 90% TSS; 30% TP; 55% TN; and 70% bacteria (RI Manual, 2010).

Next steps

This is a low priority retrofit given the complexity of design, site constraints, and the assumed integration with a larger capital construction project. It could be a good design exercise for DPW as they begin to include more stormwater practices in their construction projects.

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
12	0.39	30	849	400	3000

* Design Treatment Volume: Tv (cf) = (2”)(I)/12; I = impervious area (sf)
* Practice Area Required is calculated based on practice-specific design assumptions (e.g. depth of filter bed, coefficient of permeability, depth of ponding water, and drain time).
* Practice Area Available: estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

13. Faga'alu Park—Dry swale

Site Description

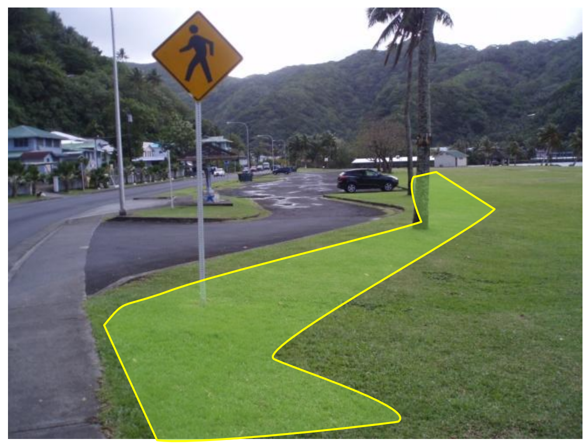
The Faga'alu Park is an approximately 4.3 acre open space recreational area along the shoreline. It consists of a large parking lot and open grass field, along with boat houses, a basketball court, and a pavilion. There is a bus stop in the parking lot. Currently, there are no water quality control stormwater management practices at the park. This site was identified previously as a low lying area where stormwater could be managed (Pedersen, 2000). Adjacent to the southern entrance, is a culvert and stream discharge from the residential hillside across Hwy 001. In addition, an underground pipe runs through the central portion of the park carrying runoff from the commercial and residential area across the street as well as from inlets in the deteriorating parking lot. This runoff goes untreated before being discharged to the bay. The park is a high visibility area and provides educational opportunities for Village residents and other park users.

Map depicting retrofit locations (blue polygons) and drainage areas to each site (red dashed line).

Proposed Concepts

Two potential retrofit projects were discussed at the Park:

13A Dry swale: Construct a dry swale from the southern entrance along the eastern edge of the parking lot to collect and infiltrate runoff from the road (Figure 10A). Divert flows coming down the road way via curb cut into the swale. In the future, when the parking lot requires repaving, re-grade to direct sheet flow into swale. Location of swale should avoid damage to existing trees. Tie overflows/outlet into existing drainage pipe located at the midway point of the parking lot.



13A. A dry swale with vegetation and underdrain is proposed in the grassy area of the park

13B Rain garden: At the northern park entrance, there are two drainage inlets, one along the road and the other in the parking lot. Unfortunately, given the existing grades, it

13B. A rain garden is proposed in the parking lot. Outlet into existing drain inlet is shown with the red arrow.

would be difficult to intercept runoff at the second inlet, which would include flow in the existing pipe and runoff coming from the restaurants across the street. However, there is space adjacent to the inlet in the parking lot closer to the road to divert parking lot runoff into a rain garden or bioretention facility. Overflow can tap back into the existing drainage inlet.

Practice Sizing/Design Considerations

The target size for the dry swale (13A) is based on managing the first two (2) inches of runoff from impervious surfaces; in this case, the available practice area estimated from the initial site visit provides more than enough space for the target total volume. In the future, if the parking lot is re-graded to drain towards the swale, there would be adequate storage to manage up to three times the current estimated impervious cover draining to the practice.

The target size for a bioretention cell is based on managing the first two (2) inches of runoff from impervious surfaces; in this case, the available practice area estimated from the initial site visit is not adequate to manage this total volume without losing existing paved parking spaces. Currently the size of the bioretention is a little more than half the required practices area.

Bioretention and Dry swales are assumed to remove 90% TSS; 30% TP; 55% TN; and 70% bacteria (RI Manual, 2010). This assumes the full design treatment volume is provided. If available space is limited, the annual load reductions would be reduced.

Next Steps

- Coordinate with the Village Mayor to determine if these retrofits are favorable options for the park and whether the loss of a couple of parking spaces would be acceptable;
- Determine the site utilities and other potential conflicts, complete a topographic survey of the area for both practices;
- Conduct soil test pits to verify subsurface conditions and depth to groundwater. If soils are favorable for infiltration, underdrain systems are not necessary.
- Determine potential to link upgrades with shoreline stabilization project (see Project #9).
- Discuss maintenance provisions and vegetation preferences with Village before final design.

Pollutant Load Reduction

Site ID	Drainage Area (ac)	% Impervious	Design Treatment Volume (cf)*	Practice Area Required (sf)*	Practice Area Available (sf)*
13A	0.53	85	3,270	1,204	3150
13B	0.34	95	2,345	1,020	585

* Design Treatment Volume: Tv (cf) = (2")(I)/12; I = impervious area (sf)
* Practice Area Required is calculated based on practice-specific design assumptions (e.g. depth of filter bed, coefficient of permeability, depth of ponding water, and drain time).
* Practice Area Available: estimated from available mapping. Actual practice area may be adjusted as needed during pre-construction.

15. Stream Crossing—Repairing the Ford

Site Description

This stream crossing is more accurately described as a ford – the main road serving the Faga'alu Village crosses the stream immediately downstream of the quarry entrance. The road surface forms a shallow dip (low point) that overflows with approximately 6 feet wide by two inches deep (this is assumed to be the normal base flow as observed during the six day period from July 20 through the 26th). The dip is constructed of heavy duty concrete slab to support the weight of the loaded trucks exiting the quarry.

The invert of the stream above the ford is at approximately the same elevation as the top of road, so water is constantly flowing over the road surface. Immediately below the ford, the flow drops approximately 3 to 4 feet down a vertical headcut. The rock base of the concrete slab appears to be stable, however close inspection was difficult due to the flowing water. Anecdotal evidence indicates that the roadway overtops with a much wider spread on the flow, causing erosion of the stream channel along the downstream reach of stream below the crossing. To cross, pedestrians get their feet wet and trucks from the quarry wash their tires.

Figure 15A. Stream baseflow pouring across the road surface.

Proposed Concepts

This concept is intended to proactively address the continued undermining of the roadway, scour of the stream channel immediately below the crossing, and pollutant loads from vehicular traffic. Options include:

1. Install a construction entrance and wheel wash area at the quarry entrance to ensure that trucks are not tracking sediment onto the roadway and into the stream at the ford.
2. Construct a box culvert or bridge to raise the roadway surface above the flow area for the designated storm event as prescribed by American Samoa DPW. This would maintain a dry road surface for the more frequent storms.
3. Protect the road in its current configuration by armoring the stream channel bed and banks below the ford. A grade control structure immediately below the ford will help prevent the headcut from migrating further upstream and undermining the road.

Pollutant Removal

This retrofit is considered a preventive retrofit, a pollutant load reduction is not applicable.

Next steps

Further inspection of the roadway and road subgrade will help establish the priority for this retrofit. Evidence of significant scour extending upstream under the roadway should prompt Option 2. If the roadway appears stable, options 1 and 3 should be implemented to protect the road and ensure minimal pollutant loads being introduced into the stream.

Appendix B

Samoa Maritime Quarry Corrective Action Plan Memorandum

CENTER FOR WATERSHED PROTECTION

Horsley Witten Group
Sustainable Environmental Solutions
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MEMORANDUM

DATE: 8/30/12

TO: Kathy Chaston, Steve Frano, and Fatima Sauafea-Leau (NOAA); Faamao Asalele, Christianera Tuitele, Kuka Matavao (AS-EPA); Marvis Vaiaga'e (AS DOC); Uso Lago'o (Faga'alu); and George Poysky (Samoa Maritime)

FROM: Horsley Witten Group, Inc. (HW) and the Center for Watershed Protection, Inc. (CWP)

RE: Corrective Action Plan for the Faga'alu Quarry

This memorandum describes a proposed Erosion and Sediment Control (ESC) Corrective Action Plan to reduce sediment loading associated with groundwater seeps and stormwater runoff at the Faga'alu quarry site. The Faga'alu quarry is located at the upper terminus of the main road serving the Faga'alu Village. Managing runoff from a quarry can be challenging due to constantly changing drainage patterns as different areas of the site are excavated and material stockpiles are relocated. The Faga'alu quarry is further challenged by limited space in which to operate. The quarry is wedged between the steep hillsides being excavated and the stream channel along the site's southern boundary. All the runoff from the quarry eventually enters the stream. Recent monitoring efforts by Curtis et al., (2021) have shown that in-stream turbidity levels are significantly greater below quarry discharge locations than upstream of the operation (Figure 1).

The goal of this Corrective Action Plan is to identify the primary drainage patterns through the quarry and develop erosion and sediment control practices for reducing the sediment loads to the stream. This project is Structural Project ID 16 in the pending *Faga'alu Watershed Plan Implementation Supplement*.

Proposed Concept

The design concepts presented here are based on observations made during watershed field assessments on July 24-25, 2012, as well as from discussions with Samoa Maritime, AS-EPA, and participants from the post-construction stormwater training workshop. Given the lack of available topographic information, site plans, or high resolution aerial imagery, our conceptual designs at this time are limited to preliminary sketches and photos taken while on site.

Figure 1. Turbidity measurements at eight locations along the main stream (stations 7-9 are above the quarry operation, 6-5 are at the quarry, and 3-1 are downstream towards Faga'alu Bay). All sites below the quarry are above the NTU water quality standard.

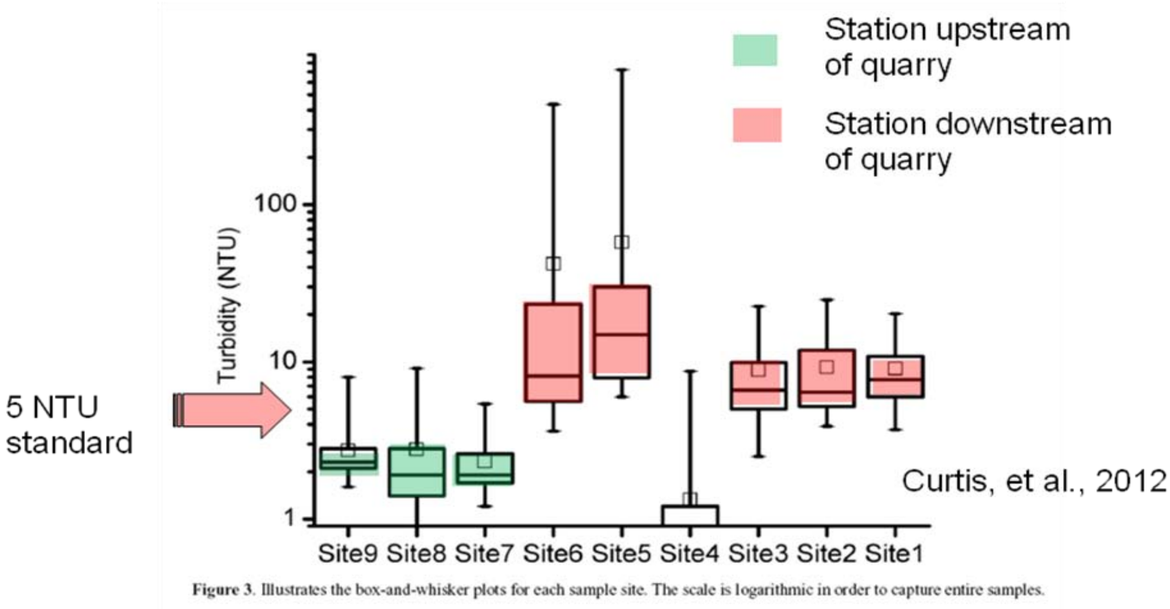


Figure 3. Illustrates the box-and-whisker plots for each sample site. The scale is logarithmic in order to capture entire samples.

The following is a general description of the proposed steps for implementing the Corrective Action Plan at the Faga'alu quarry. The quarry is generally divided into three primary operational areas as follows:

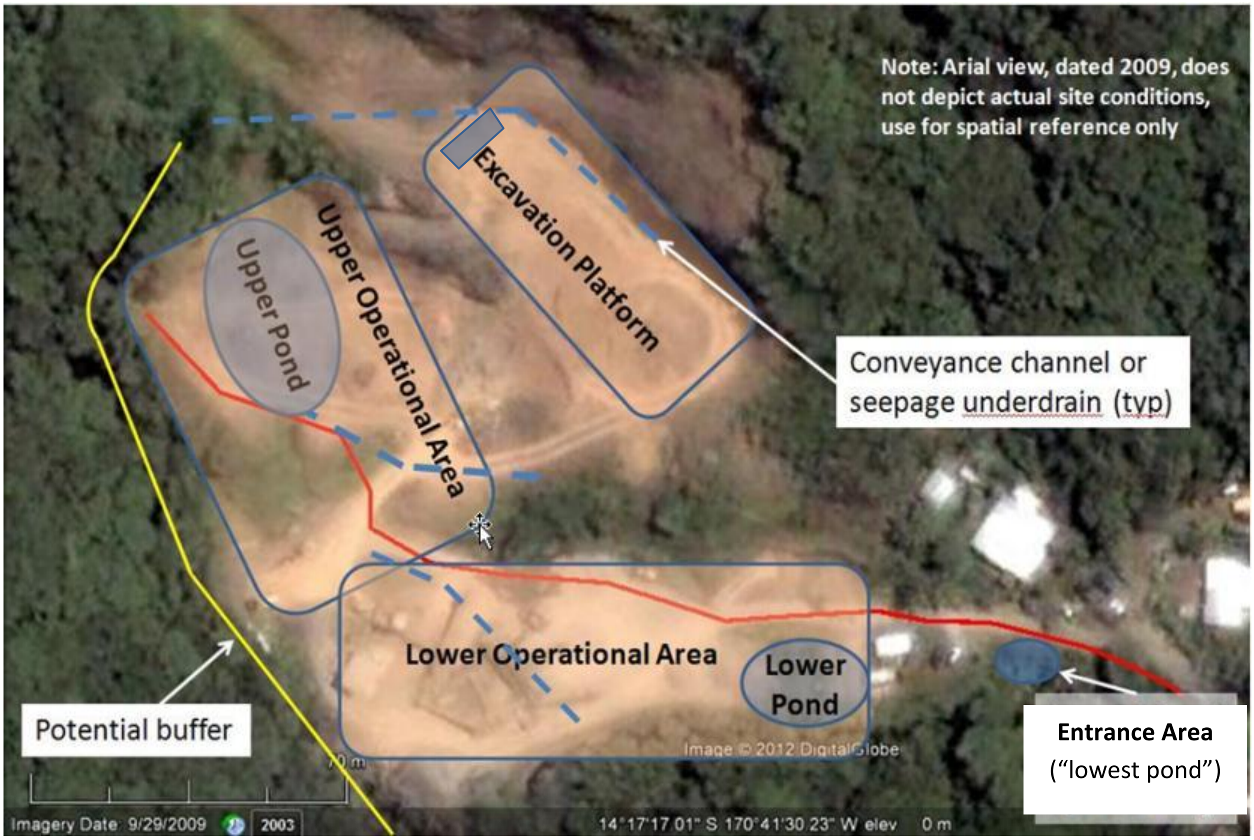
1. **Excavation Platform**: this area is located at the base of the uppermost hillside and serves as a staging area for excavation equipment to travel up a temporary switchback road that accesses the upper elevations of the mining operation. This area is depicted in the lower half of Photo 1B (photo is looking generally south-east from the top of the switchback access road). A small tracked drilling rig is shown on one of the upper switchbacks (lower right in photograph), while the two large tracked excavators are shown in the general vicinity of the excavation platform and the entrance to the switchback access road. A large excavated pit is seen to the middle right of the photograph; this area exposes a sheer rock face (seen in Photo 2).

2. **The "Upper Operations" area**: this area includes the access to the rock crushing equipment hopper, and includes the current location of the explosives shed, fuel storage shed, and miscellaneous equipment storage and material stockpiles.

3. **The "Lower Operations" area**: this area includes the rock crushing operation area, as well as the numerous stockpiles, access drive aisles, and main entrance driveway that serve the lower portion of the quarry.

The proposed corrective actions are likewise developed to address these three operational areas, as well as actions at the entrance gate and along the length of the adjacent stream (Figure 2). Each of these actions is described below in more detail. Concept sketches are provided in Appendix A, and a photo log of the site is provided in Appendix B.

Figure 2. Aerial photo depicting locations of primary operational areas and corrective actions. The red line is an existing road line from GIS.



Excavation Platform

A steady flow of groundwater seeps out of the vertical rock cut at the upper end of the quarry. This seepage ponds in the flat area and eventually drains down the access road where it then travels the full length of the active work area of the quarry. The water combines with flow from other groundwater seeps as well as surface runoff during and shortly after rain events before leaving the site at a single location. Excavation equipment and trucks cross the combined flow in at least three locations.

The following steps are intended to isolate the clean groundwater seepage and convey it to the stream without interacting with active operational areas.

1. Intercept the flow at the base of the rock seep with a rock trench drain and perforated pipe. Sheet 1 of 3 of Concept Sketch and Section A-A on Sheet 3 of 3.

2. Install a small sediment trap at the furthest north-western most portion of the excavated work pad.
3. Grade the excavation platform to drain the western-most third of the platform area to a sediment trap that overflows to the rock trench drain. Grade the remainder to drain out the entrance to the conveyance to the Upper Pond serving the Upper Operations Area.

Groundwater Seepage Collection Channel	
Length of channel – perforated pipe (4” to 6” diameter)	275 ft
Stone (4” to 6”)	50 cu yds
Stone (No. 2)	7 cu yds
Filter fabric	150 sq yds

Sediment Trap*	
Approximate Surface Area	150 sq ft
Excavation	30 cu yds
Dry Storage	15 cu yds
Wet Storage	15 cu yds

*Sediment trap is sized to only capture a small portion of the Excavation Platform as shown on design concept sketch (approximately 4,000 sq.ft.; or 0.1 ac)

Upper Operations Area (Upper Pond)

1. Bench the haul road (towards the mountain) that switchbacks up the hillside above the work area to keep the drainage that comes off the mountain contained in a roadside channel. This should help prevent excessive sediment from washing down the hillside as well as minimize gullying, and rock slides. See Detail on Sheet 3 of 3 of Concept Sketch.
2. Intercept work pad and haul road runoff at the base of the road and direct it across the road through a culvert (so as to minimize disturbance from equipment traffic).
3. Discharge culvert into a stone lined surface channel diversion channel (Design Concept Sketch Sheet 1 of 3, Section B-B). Conveyance channel drains to proposed sediment basin (Upper Pond or settling pond in figure below). (Also reference to Photo 7, and Photo 7A in Photo Album)
4. Relocate the excavation equipment and the port-a-john from the existing location at the top of the stream bank. (Photo 12 in Photo Album).
5. Sediment Basin Design: Typical USDA Sediment Basin design is sized on a 1” depth of runoff per acre of drainage area. Given the rainfall in American Samoa, the sizing for the sediment basin is increased to 1.5” depth of runoff, or 200 cu yds/acre of contributing drainage area. The storage volume is split between wet storage (lower elevations of the basin) and dry storage (storage available for runoff to fill the basin).

Upper Operations Area Culvert*	
Length	60 ft
Diameter	30 in
Slope	1%

*Culvert size assumes design peak discharge of 26 cfs, 1% slope (DA = 12 acres, 4 acres disturbed, C=0.37, I=6"/hr)

Conveyance Channel*	
Length of Channel	235 ft
Stone (4" to 6")	87 cu yds
Filter Fabric	260 sq yds

*Channel dimensions based on 26 cfs, 1% slope: 2 ft bottom width, 2:1 side slopes, depth of channel = 2 ft (min), depth of flow=1.4 ft, velocity=4.2 ft/s,

Upper Settling Pond*	
Contributing drainage Area	12 ac
Approximate surface area available	7,000 sq ft
Approximate surface area required (assumes 12 ft depth)	9,600 sq ft
Excavation bottom area (assumes 2:1 side slopes,)	2,500 sq ft
Overflow spillway design capacity (10-year design Storm)	*
Overflow spillway dimensions	*
Overflow spillway stone (avg. 12")	*
Overflow spillway top stone (4" to 6")	*

*Capacity of basin overflow spillway to be determined using 10-yr design storm criteria (established by ASDPW). Grading plan should account for adequate freeboard (min 1ft) for the design storm to overflow the spillway.

Lower Operations Area (Lower Pond)

1. Collect seepage at the base of the cut slope adjacent to the rock crushing equipment. (Photo 8 Photo Album). The collection channel should be configured similar to Section A-A on Sheet 3 of 3.
2. Seepage is conveyed across the Lower Operations area with a gravel diaphragm (an enclosed stone channel with perforated drain tile); wrapped in filter fabric and covered with a cap layer of crusher-run gravel to serve as a driving surface. Sheet 2 of 3 of Concept Sketch and Section C-C on Sheet 3 of 3 of Concept Sketch.
3. Grade the lower operations area to sheet flow to perimeter conveyance swales to be located away from active drive aisles that are currently acting as channels draining the site. Photos 9 & 10, Photos 5, 6 and 11. Swales should convey flow to Lower Settling Pond (Sheet 2 of 3 of Concept Sketch, Photo 11 A of Photo Album). This area should be cleared of existing gravel stockpiles (west side of channel) and equipment (shipping container and various disabled excavation equipment) as needed so as to install a large sediment basin (Lower Settling Pond) with the discharge at the same location as the current channel outlet.

Groundwater Seepage Collection Channel	
Length of channel – perforated pipe (4” to 6” diameter)	160 ft
Stone (4” to 6”)	18 cu yds
Stone (crusher-run)	15 cu yds
Filter fabric	125 sq yds

Lower Settling Pond*	
Contributing drainage Area	1.4 ac
Approximate surface area available	3,500 sq ft
Approximate surface area required (assumes 8 ft depth)	2,600 sq ft
Excavation bottom area (assumes 2:1 side slopes)	250 sq ft
Overflow spillway design capacity (10-year design Storm)	*
Overflow spillway dimensions	*
Overflow spillway stone (avg. 12”)	*
Overflow spillway top stone (4” to 6”)	*

*Capacity of basin overflow spillway dimensions to be determined using 10-year design storm criteria as established by ASDPW. Grading plan should also account for adequate freeboard (min 1ft) for the design storm to overflow the spillway.

Remaining corrective actions for other location on the site include:

Entrance Area

This area is currently located outside the entrance gate and is currently in place primarily due to the excessive amount of drainage that leaves the site. With the installation of the measures described above, the active drainage to this location will be reduced significantly, and sediment loads potentially eliminated with the installation of a stabilized construction entrance. If needed, a small sediment trap can be installed (“Lowest Pond” on Figure 2) once the actual drainage area is determined. Approximately 450 sq ft of space is available.

Stream Buffer

The designation of a 50 foot stream buffer or an alternative design in lieu of a buffer will require coordination with the minimum requirements for adequate truck traffic movement and access to storage locations. Ideally, any changes in traffic or operational patterns should improve conditions. Several areas noted during the site visit were very well protected even though the 50 foot buffer was not in place.

Dust Control

To be determined in coordination with available technology and equipment.

Good Housekeeping

Good housekeeping measures should be adopted by the quarry operator to help reduce the sediment load associated with normal operations. These measures include (but are not limited to) stabilized (graveled) drive aisles; oil and hydraulic fluid collection pans in designated vehicle maintenance areas; and perimeter control and/or stabilization for soil stockpiles that will remain dormant for more than 14 days, etc.

Next Steps

The available areas for the proposed settling basins were estimated and the designs included herein were based on assumptions of construction depth and side slopes, the following tasks will need to be completed before moving to construction:

Immediate Actions:

1. **Site survey and base map.** The survey/base map should include 1-ft topographic contours; site property boundaries; edge of stream; existing tree line; 50-ft buffer; edge of haul roads; and the locations of permanent equipment and structures, and designated stockpile areas). Ideally, the survey would be completed by a local land surveyor, or possibly another government partner (USACE, AS DPW). The basemap should be provided to the design engineer digitally (e.g., AutoCAD file). This task could be started immediately and would likely take approximately two weeks of combined field and office time to produce an appropriate base map.

2. **Feasibility Assessment of Corrective Action Plan.** Samoa Maritime, AS-EPA and AS DOC at a minimum should review this memorandum and provide comments on the concept design approach. Specifically, operational concerns, practice placement and feasibility of construction and maintenance should be reviewed. How does our initial proposed action plan look? A Webex conference call should be set up to discuss feedback.

3. **Engineer licensing.** Determine if an AS licensed engineer is required to stamp plans.

1 month from completion of previous tasks:

4. **Final design plans for construction**. If the actual conditions vary from our concept design, the designs will be adjusted accordingly in order to still meet the basic sizing criteria. Final design plans to include calculations to confirm practices are big enough and coordination with AS-DWP and AS-EPA to verify appropriate hydrologic design parameters. This will be a few weeks of work.

5. **Permitting.** We would need to identify which permits would need to be submitted. We assume support by AS-EPA or land survey company (perhaps) to assist in the processing of permit applications. We believe the permits will be limited to the basic construction permit,

but also recommend filing an NOI under the NPDES multi-sector general permit for this site. We do not think this corrective activity is within USACE jurisdiction, requiring a 404 permit.

6. Generate a material quantities take-off and unit cost estimate. Cost estimates will need to be done in close coordination with the project partners to reflect local costs for hauling and disposal of excavated materials and equipment and material costs. For funding purposes, if Samoa Maritime provides equipment, rock, etc., the costs could be reduced. Identify any construction materials that will need to be procured off-island.

2-3 months from initial tasks:

7. **Permit Submittal.** Submit completed permit applications. Include Maintenance Plan and Stormwater Pollution Prevention Plan (SWPPP) for submittal with NOI. This will likely involve working closely with Samoa Maritime to develop an Operational Plan. As ongoing quarry operations lead to alterations of sites conditions and drainage patterns, the operational plan or the ESC plan must be properly adapted to the new conditions while still achieving the functional goal of controlling sediment.

8. **Bid Support:** Engineering design firm to provide construction specifications and support AS-EPA or other partners in soliciting contractor.

During Construction:

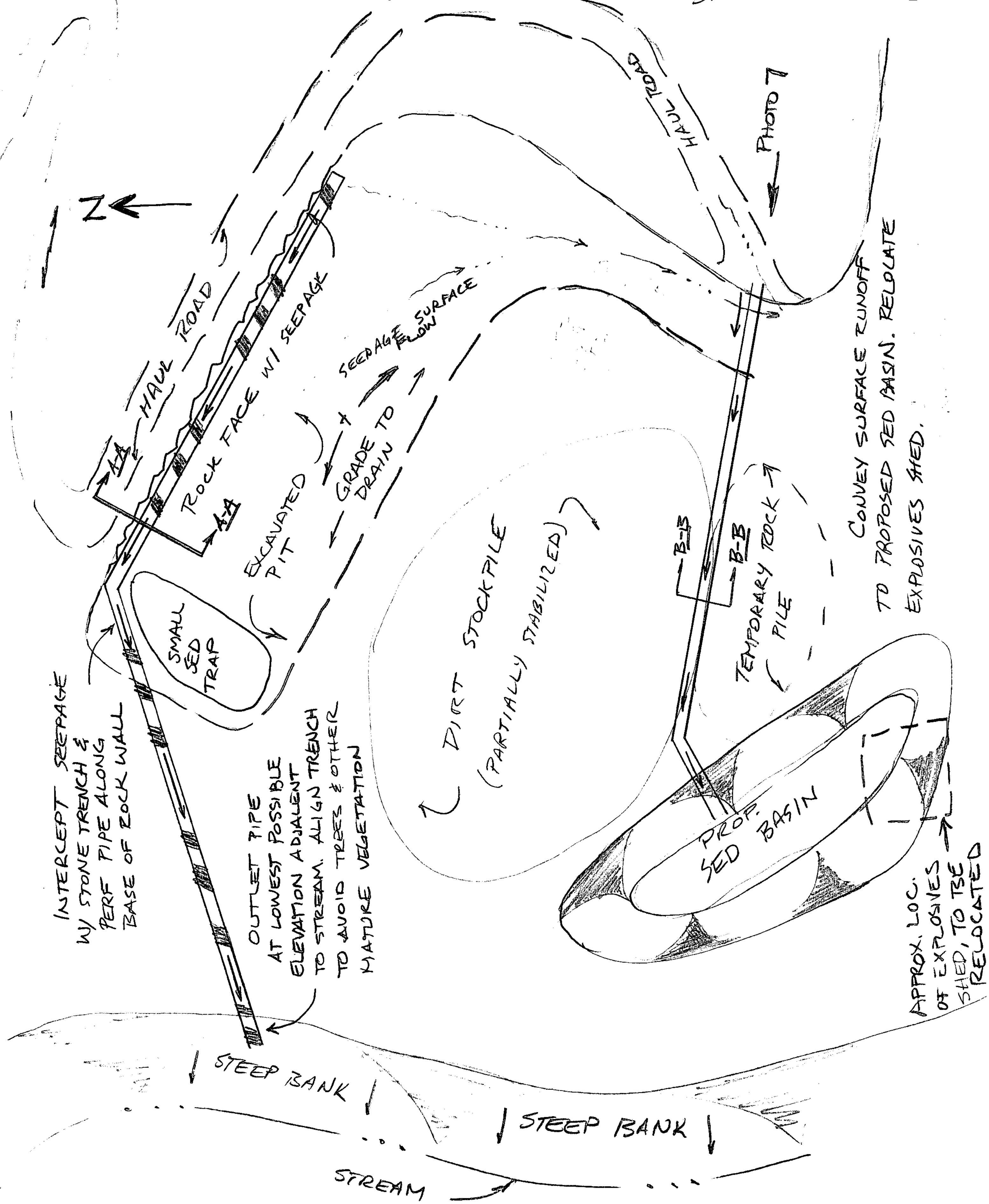
9. **Construction oversight.** Design engineer, or designated on-the-ground alternate (As-EPA?) should be on site for a pre-construction meeting and at key intervals during the construction process. Construction notes should include required check in with the design engineer, at critical steps in the construction sequence to make sure installation is occurring appropriately. As-built plans should be submitted to AS-EPA before construction is considered complete.

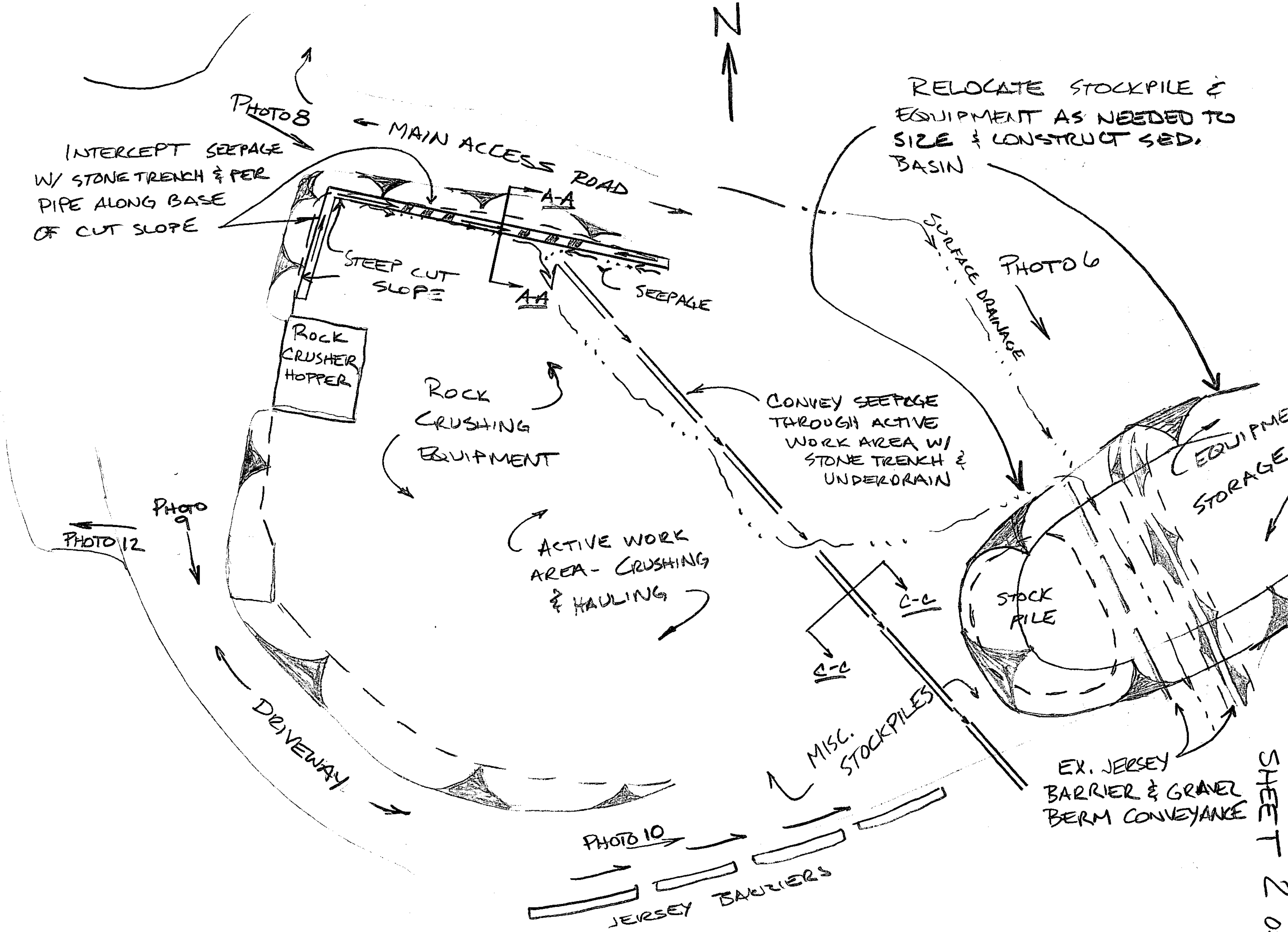
After Construction:

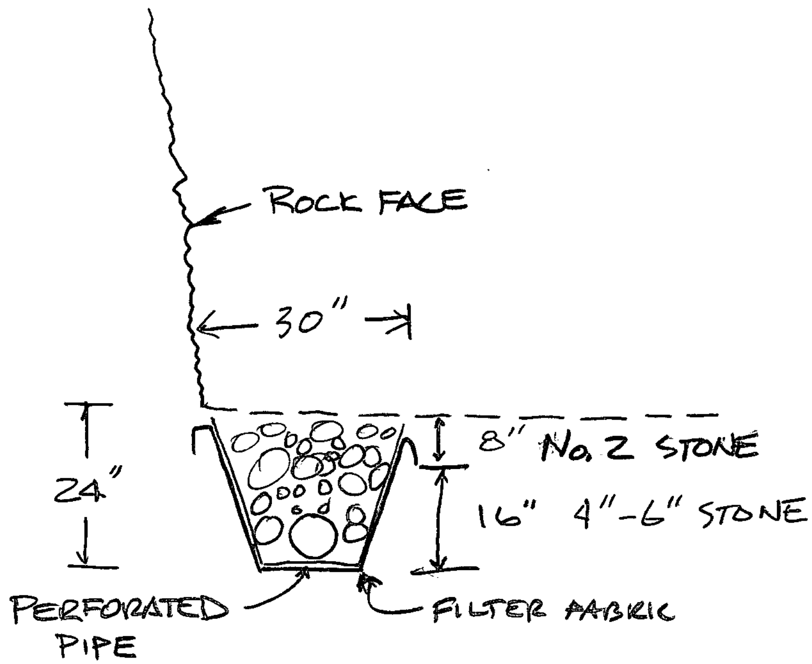
10. **Monitoring.** In-stream turbidity samples should be collected during construction and for a defined period of time after construction is completed in order to quantify effectiveness of corrective actions (e.g., San Diego State University).

Appendix A

Preliminary Sketches

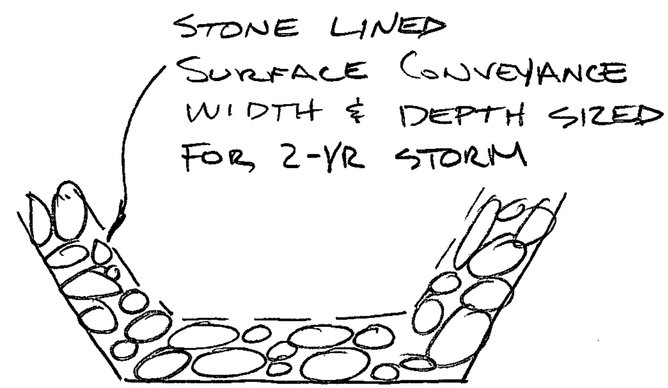

N
HAUL ROAD
HAUL ROAD
PHOTO 7
ROCK FACE W/ SEEPAGE
A-A
A-A
SEEPAGE SURFACE FLOW
GRADE TO DRAIN
EXCAVATED PIT
SMALL SED TRAP
DIRT STOCKPILE
(PARTIALLY STABILIZED)
B-B
B-B
TEMPORARY ROCK PILE
CONVEY SURFACE RUNOFF TO PROPOSED SED BASIN. RELOCATE EXPLOSIVES SHED.
PROP. SED BASIN
APPROX. LOC. OF EXPLOSIVES SHED, TO BE RELOCATED
INTERCEPT SEEPAGE W/ STONE TRENCH & PERF PIPE ALONG BASE OF ROCK WALL
OUTLET PIPE AT LOWEST POSSIBLE ELEVATION ADJACENT TO STREAM. ALIGN TRENCH TO AVOID TREES & OTHER MATURE VEGETATION
STEEP BANK
STEEP BANK
STREAM


N
RELOCATE STOCKPILE & EQUIPMENT AS NEEDED TO SIZE & CONSTRUCT SED. BASIN
PHOTO 8
MAIN ACCESS ROAD
INTERCEPT SEEPAGE W/ STONE TRENCH & PER PIPE ALONG BASE OF CUT SLOPE
A-A
A-A
STEEP CUT SLOPE
SEEPAGE
SURFACE DRAINAGE
PHOTO 6
ROCK CRUSHER HOPPER
ROCK CRUSHING EQUIPMENT
CONVEY SEEPAGE THROUGH ACTIVE WORK AREA W/ STONE TRENCH & UNDERDRAIN
EQUIPMENT STORAGE
PHOTO 9
PHOTO 12
ACTIVE WORK AREA - CRUSHING & HAULING
C-C
C-C
STOCK PILE
DRIVEWAY
MISC. STOCKPILES
EX. JERSEY BARRIER & GRAVEL BERM CONVEYANCE
PHOTO 10
JERSEY BARRIERS



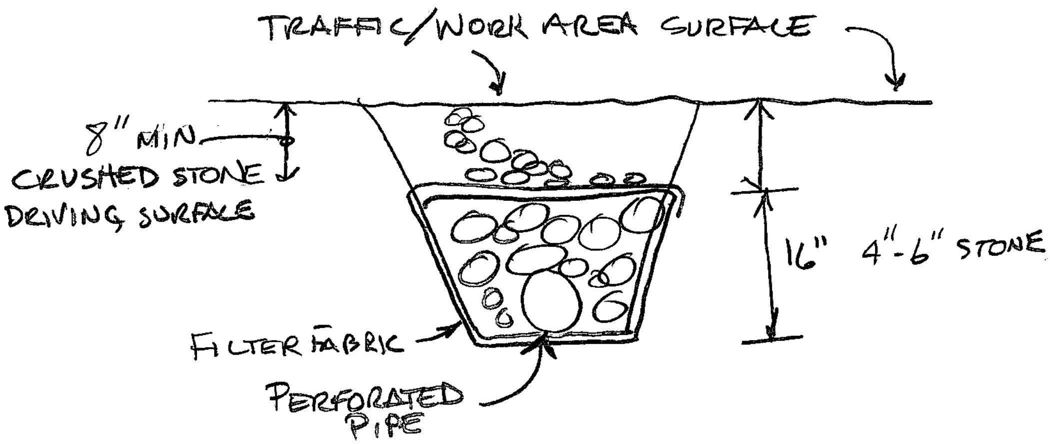
SECTION A-A

NOT TO SCALE



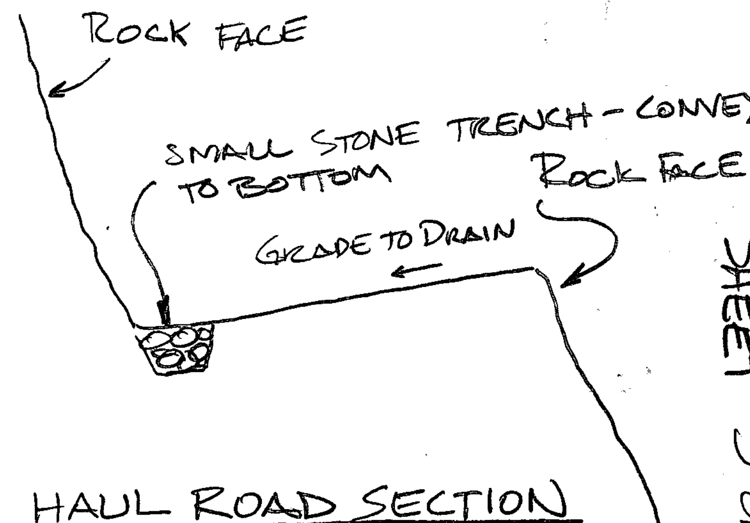
SECTION B-B

NOT TO SCALE



SECTION C-C

NOT TO SCALE



HAUL ROAD SECTION

Appendix B

Photo Log

Faga’alu Quarry Site Visit Photo Album
July 22 & 23, 2012

by Horsley Witten Group

&

The Center for Watershed Protection

Field Data Collection- iPAD: initial area calcs and pipe lengths

Upper Pond

Watershed Area = 11.9 acres
Disturbed Area = 4.6 acres
Underdrain Pipe = 267 ft
Surface Runoff Pipe/Channel to Pond = 295 ft
Pond Surface Area = 7,000 sq ft.

Lower Pond – Rock Crushing Area

Watershed Area = 1.4 acres (all assumed to be disturbed)
Underdrain pipe length = 160 ft
Pond Surface Area = 3,500 sq ft.

Lowest Pond (entrance beyond gate)

Watershed Area = 0.13 acres (assume 50% disturbed)
Pond Surface Area = 450 sq ft.

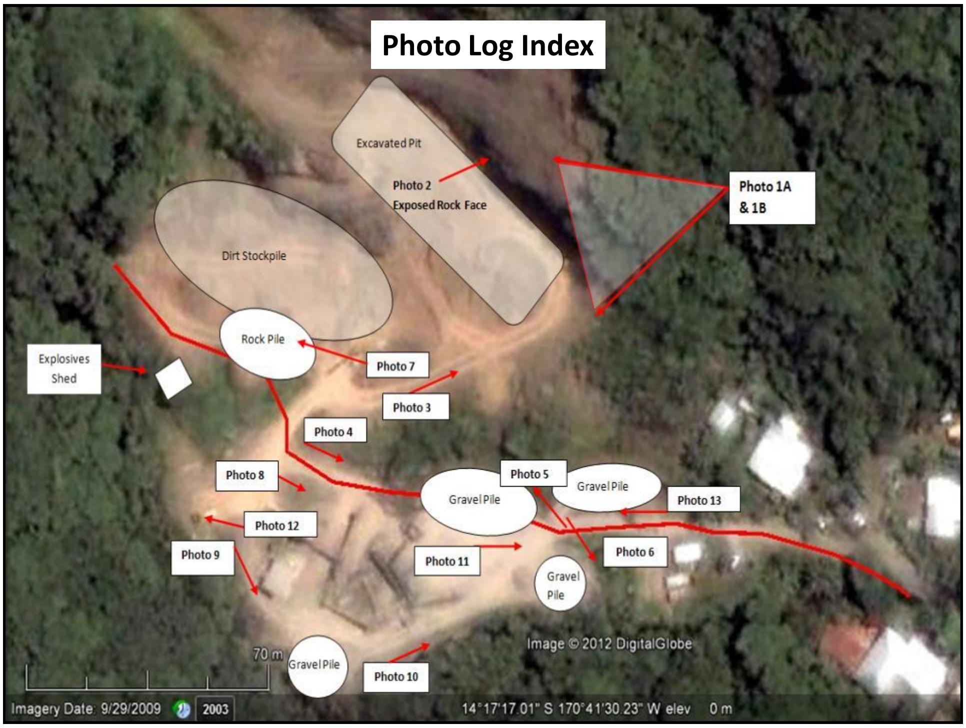
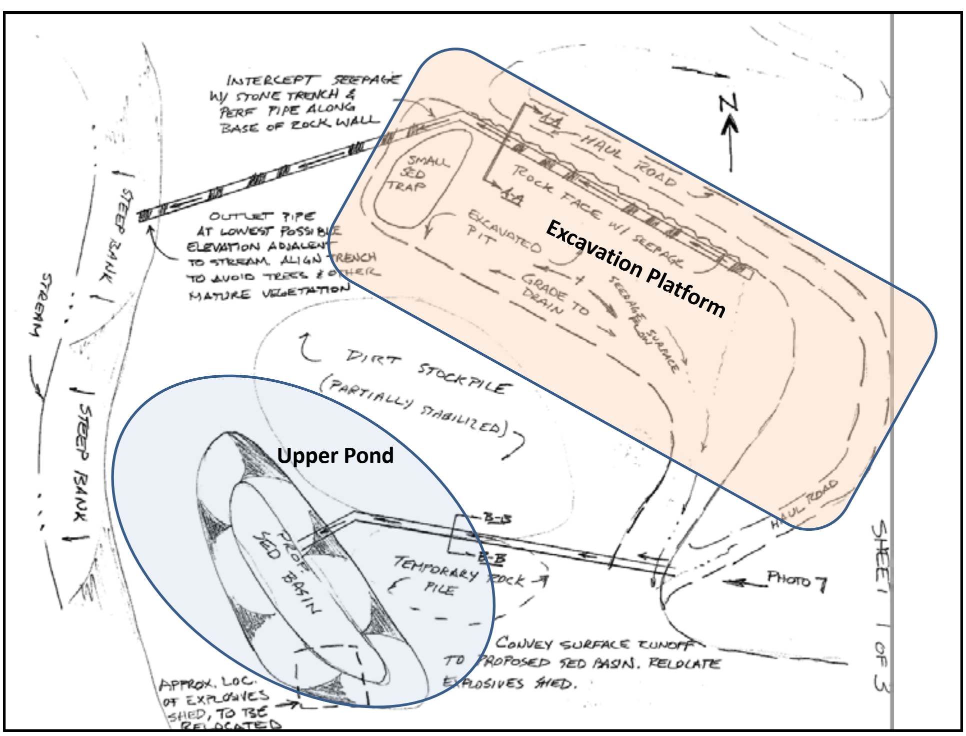


Photo Log Index
Excavated Pit
Photo 2
Exposed Rock Face
Photo 1A & 1B
Dirt Stockpile
Rock Pile
Explosives Shed
Photo 7
Photo 3
Photo 4
Photo 8
Photo 5
Gravel Pile
Gravel Pile
Photo 13
Photo 12
Photo 9
Photo 11
Photo 6
Gravel Pile
70 m
Gravel Pile
Photo 10
Image © 2012 DigitalGlobe
Imagery Date: 9/29/2009
2003
14°17'17.01" S 170°41'30.23" W elev 0 m


INTERCEPT SEEPAGE W/ STONE TRENCH & PERF PIPE ALONG BASE OF ROCK WALL
N
HAUL ROAD
ROCK FACE W/ SEEPAGE
SMALL SED TRAP
EXCAVATED PIT
Excavation Platform
OUTLET PIPE AT LOWEST POSSIBLE ELEVATION ADJACENT TO STREAM. ALIGN TRENCH TO AVOID TREES & OTHER MATURE VEGETATION
GRADE TO DRAIN
SEEPAGE SURFACE FLOW
STEEP BANK
STREAM
DIRT STOCKPILE (PARTIALLY STABILIZED)
Upper Pond
PROP. SED BASIN
B-B
TEMPORARY ROCK PILE
HAUL ROAD
PHOTO 7
SHEET 1 OF 3
CONVEY SURFACE RUNOFF TO PROPOSED SED BASIN. RELOCATE EXPLOSIVES SHED.
APPROX. LOC. OF EXPLOSIVES SHED, TO BE RELOCATED

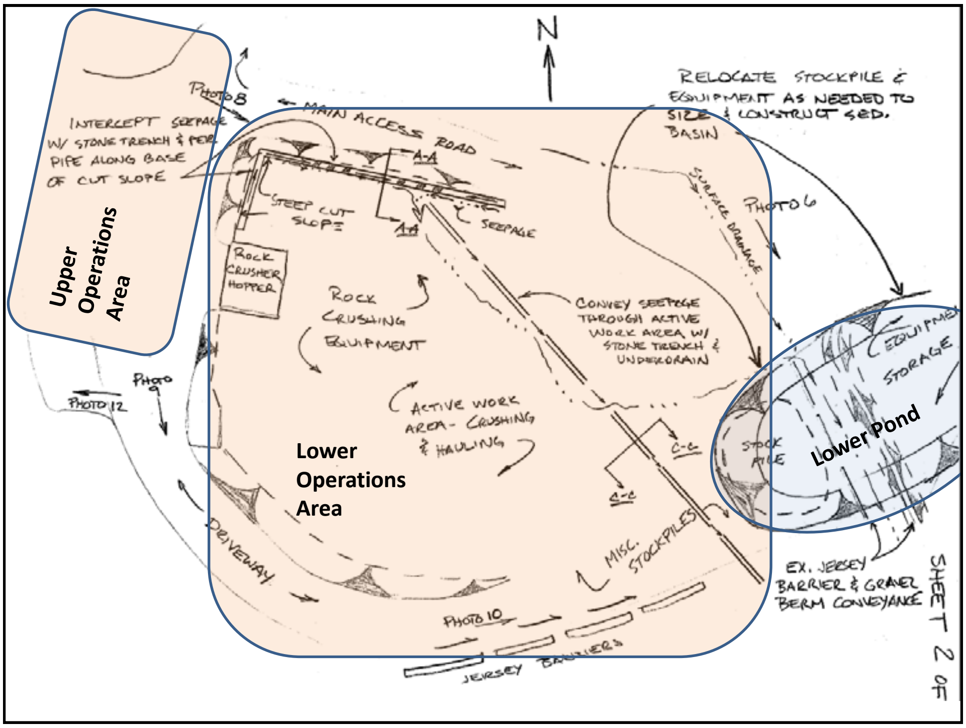


Photo 1A – View from the switchback haul road above the rock face; Excavated pit seen at lower left, explosives shed at upper center, and rock crushing equipment at left center.

Photo 1B – View from the switchback haul road above the rock face; Excavated pit seen at lower left, explosives shed at upper center, and rock crushing equipment at left center.

Photo 2 – Exposed rock face at bottom of excavation. Continuous seep along the entire toe of the excavation.

Photo 3 – View looking up at excavator operating at toe of rock face. Switch back haul road (3 turns) is seen winding up the hill side in background .

Photo 4 – Groundwater seep from excavated area collects and is conveyed down the primary driveway to the site

Photo 5 – View looking back uphill at the seepage after it has traveled down the primary driveway, squeezed between the gravel stockpiles and back across the driveway

Photo 6 – Groundwater seepage (and runoff during rainfall events) eventually leaves the site through a small channel between jersey barrier and gravel berm, and an undersized sediment trap.

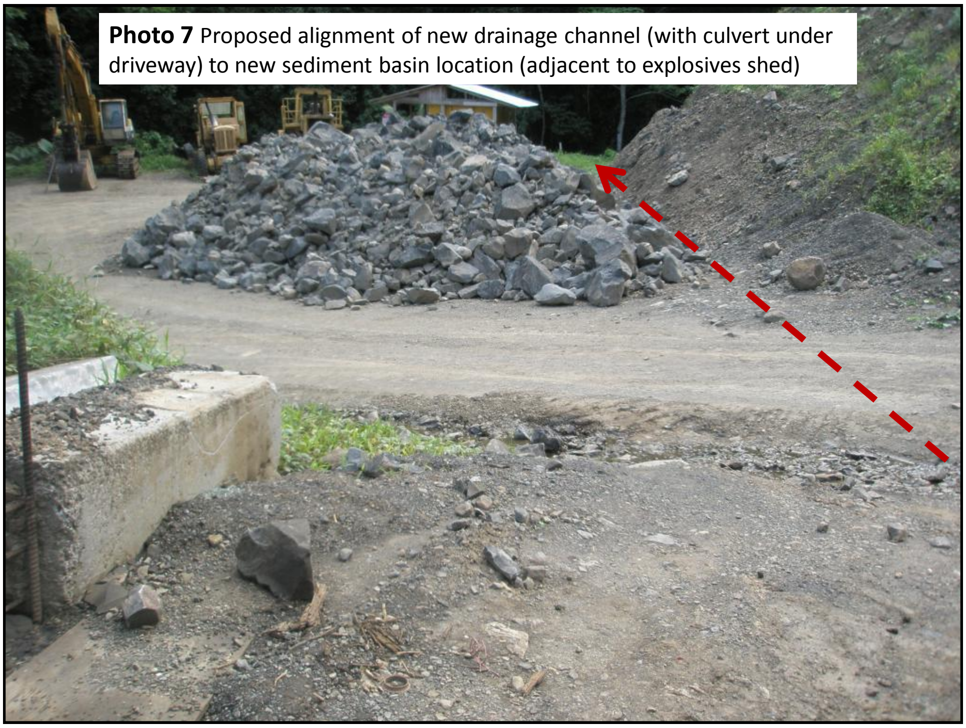


Photo 7 Proposed alignment of new drainage channel (with culvert under driveway) to new sediment basin location (adjacent to explosives shed)

Photo 7A – Schematic of Upper Pond location. Image shows culvert under access road to Excavation Platform, and the alignment of the conveyance channel to the proposed settling pond.

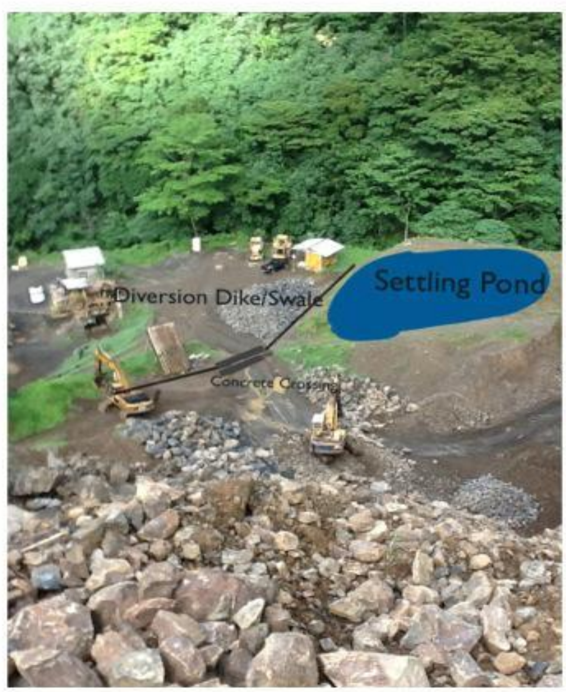


Photo 8 – View of groundwater seep at edge of cut that creates the rock crushing equipment pad; seepage eventually drains across active work area and combines with runoff before exiting site.

Photo 9 – Access road from rock crusher hopper around the fuel shed. Conveys runoff down towards the active work area.

Photo 10 – Runoff continues downhill along edge of roadway (and adjacent to jersey barrier).

Photo 11 – Runoff combines with seepage and drains to outlet (Photo 6) through the active traffic/work area.

Photo 11A – Gapped panorama of location for Lower Settling Pond. Area to the right is currently a random stockpile area that has been recently cleared. Area to the left contains disabled excavation equipment and a storage container. Center photo shows the channel leaving the site (refer to Photo 11).

Photo 12 – Construction equipment and port-a-john located adjacent to stream bank with minimal buffer.

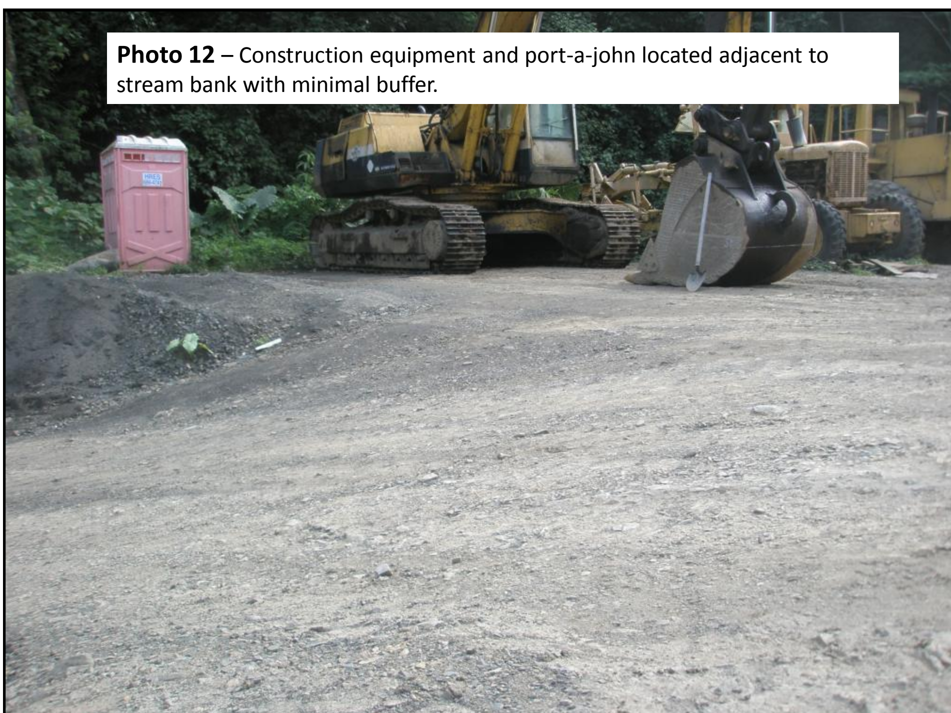


Photo 13 – Stockpile instability immediately adjacent to main driveway